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(54) Tracking control device for magnetic recording/reproducing apparatus.

(57) A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is successively moved in the widthwise direction of a magnetic tape for switching tracking positions so that data recording/reproducing is, by each of the plurality of magnetic heads, performed along a plurality of data tracks formed on the magnetic tape in parallel to a direction in which the magnetic tape moves. The tracking control device has at least two servo signal reproducing heads provided integrally with the head unit and provided for the purpose of reproducing servo signals for tracking use from a plurality of servo tracks formed in parallel to the data tracks on the magnetic tape, and movement control unit for controlling, at each of the tracking positions, movement of the head unit in the widthwise direction in accordance with the difference in two servo signals reproduced by adjacent two of the servo signal reproducing heads corresponded to each of the tracking positions.

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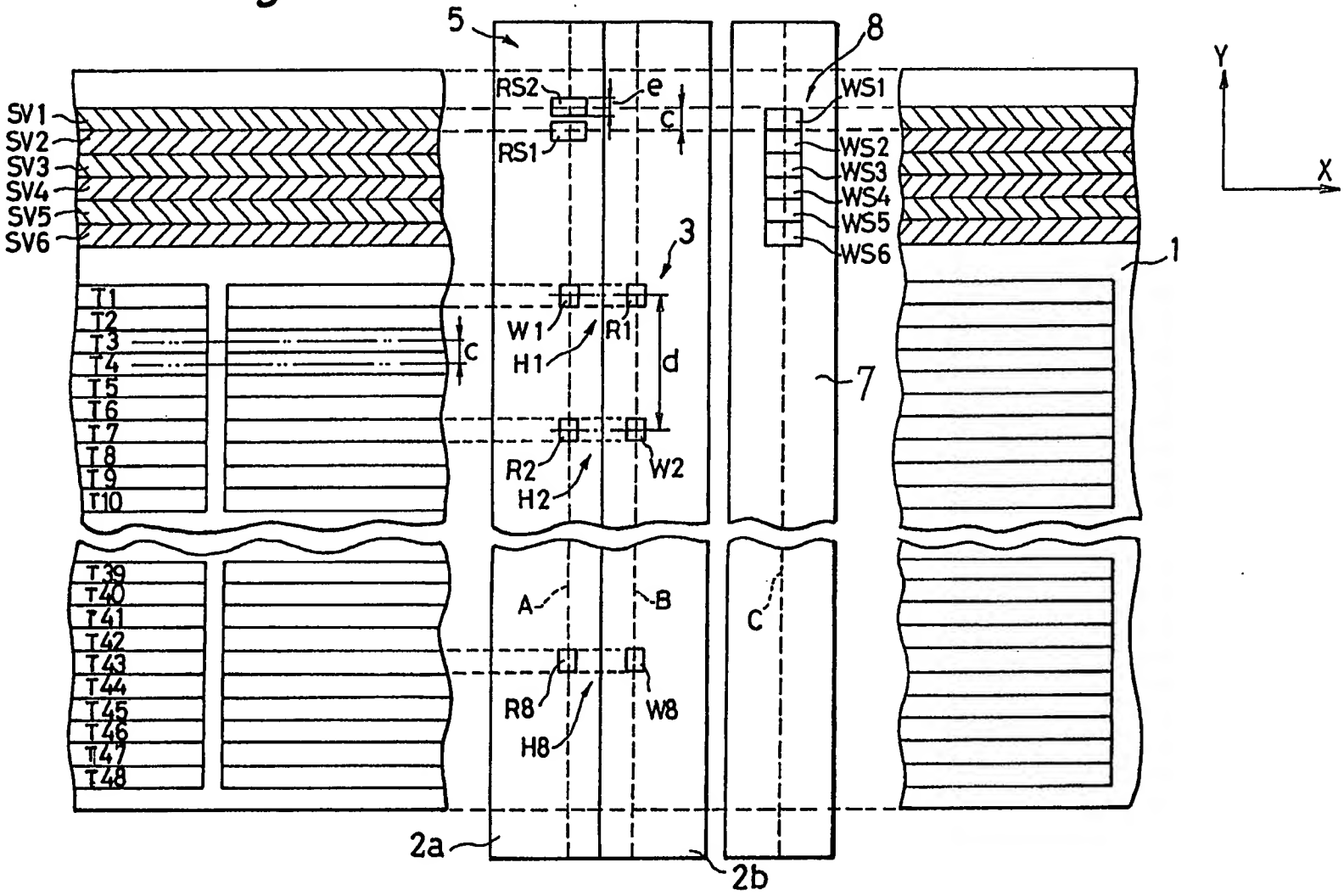
Fig. 2A


5
8
RS2
e
c
RS1
WS1
WS2
WS3
WS4
WS5
WS6
SV1
SV2
SV3
SV4
SV5
SV6
3
1
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
W1
R1
H1
c
d
7
R2
H2
W2
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48
A
B
C
R8
H8
W8
2a
2b
Y
X

TRACKING CONTROL DEVICE FOR MAGNETIC RECORDING/REPRODUCING APPARATUS

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention relates to a tracking control device for a magnetic recording/reproducing apparatus for recording/reproducing information along a plurality of tracks running in parallel to the direction in which a magnetic tape moves by successively moving magnetic heads in the widthwise direction of the magnetic tape.

(2) Description of the Related Art

Hitherto, a magnetic recording/reproducing device for use in an audio apparatus has been usually arranged in such a manner that the number of the tracks and that of the heads are the same except for devices having a rotary head. The "number of the tracks" means the total number of data tracks formed in parallel to a direction in which the tape moves. The "number of heads" means the number of magnetic heads included by a combination head which integrally has magnetic heads such as the recording heads and reproducing heads or the recording/reproducing heads. A magnetic recording/reproducing apparatus of the type described above is provided with tape head relative position restricting means for restricting the relative position between the magnetic tape and the magnetic head. A typical restricting means has a guide post in which there is formed a pair of flanges for guiding the two widthwise directional ends of the magnetic tape.

Since the above-described tape head relative position restricting means is arranged to prevent the vertical waving of the magnetic tape by bringing the two ends of the magnetic tape into contact with the flanges, there arises a fear, when a magnetic tape the width of which is larger than the distance between the two flanges is moved, in that the two ends of the magnetic tape can be damaged due to mechanical stress applied to the two ends of the magnetic tape. Since the magnetic tape must be protected from damage, it has been difficult to improve the accuracy in positioning the magnetic tape up to several tens of micromillimeters. What is even worse, the above-described problem experienced with a high density magnetic recording/reproducing apparatus the allowable offtrack quantity of which is in a range between a level of ten and several tens of millimeters cannot satisfactorily be overcome by simply restricting the positional movement of the magnetic tape by the above-described flanges.

Recently, thin film magnetic heads have been advanced, causing combination heads of a type having a large number of heads to be developed. Therefore, the degree of density in the multi-track magnetic recording/reproducing apparatus can further be raised. The apparatus of the type described above is able to record data to a track having a narrower width. However, also the allowable offtrack is reduced. Therefore, an apparatus of the type described above have a tape head relative position restricting means arranged to comprise, in addition to the above-described flanges, control means for causing the magnetic head to follow waving of the magnetic tape by its means for detecting the relative position between the magnetic head and the magnetic tape or between the magnetic head and a track and head drive means for moving the magnetic head in the widthwise direction of the tape.

The above-described apparatus is exemplified by a fixed head digital audio tape recorder arranged in such a manner that the number of the heads and that of the tracks are the same.

The above-described apparatus is, as disclosed in Singaku Giho EA83-56, Shingaku Giho EA81-64 and Sharp Giho 1984-28, arranged in such a manner that a servo only track recorded on a magnetic tape is traced by a pair of reproducing heads disposed in parallel to each other in the widthwise direction of the tape. The thus obtained reproduced outputs are subjected to a comparison so that a following control is performed. As a result, the relative position between the magnetic head and the magnetic tape is restricted.

As another example of the tape head relative position restricting means, a control device of a magnetic recording/reproducing apparatus which is arranged in such a manner that the number of the heads and that of the tracks are the same has been disclosed (Japanese Patent Publication No. 63-64811). The control device is arranged in such a manner that a tracking signal is recorded along an end of the magnetic tape in the widthwise direction. The tracking signal thus recorded is reproduced by a servo reproducing head so as to subject the reproduced signal level to a comparison with a reference level. As an alternativ to this, tracking information is recorded along the two ends of the magnetic tape in the widthwise direction. The thus recorded tracking information is reproduced by a pair of servo reproducing heads. The levels of the two reproduced signals are subjected to a comparison with each other. As a result, the tracking is performed.

Since the multi-track magnetic recording/reproducing apparatus such as th above-described fixed head

digital audio tape recorder is arranged in such a manner that the track pitch is about hundreds of micromillimeters, a combination head in which a plurality of recording heads and reproducing heads are integrally formed can be used by employing a thin film head, the plurality of recording heads and the reproducing heads correspond to a plurality of tracks formed on the magnetic tape.

In order to further raise the recording density, the track width can be reduced by reducing the gap width of the magnetic head. However, since the degree of integration of the thin film head involves a certain limitation, the track pitch cannot be reduced satisfactorily. What is even worse, when the number of the heads is increased, the size of the circuit will be enlarged, causing an excessive cost to be raised. Therefore, a high density magnetic recording/reproducing apparatus which is arranged in such a manner that the track pitch is several tens of micromillimeters and the number of the tracks is several tens to hundreds cannot be realized by a structure in which the number of the heads and the number of the tracks are the same.

Accordingly, a recording system called a serpentine system has recently been employed in a multi-track magnetic recording/reproducing apparatus which is a backup storage device for an information processing system and which is usually called a cassette streamer, the serpentine system being arranged in such a manner that the number of the heads is smaller than the number of the recording heads.

The serpentine system will be described with reference to Fig. 1. A magnetic tape 21 which moves in direction X and the width of which is designated by Y has a track group 22 composed of 16 tracks T_1 to T_{16} which are, for example, formed in direction Y at equal pitch a. A combination head 23 is disposed to correspond to the above-described track group 22, the combination head 23 comprising, for example, four recording heads W_1 to W_4 and four reproducing heads R_1 to R_4.

The recording heads W_1 to W_4 are disposed in the direction Y at same pitch b (b = 4a), each of the reproducing heads R_1 to R_4 being arranged to form a pair in cooperation with corresponding recording heads W_1 to W_4 disposed in direction X or - X.

When the recording or reproducing operation is performed, the above-described combination head 23 is first moved to a position shown in Fig. 1. That is, it is moved to a position at which the center of the recording head W_1 and that of the reproducing head R_1 coincide with the center of the track T_1, the center of the recording head W_2 and that of the reproducing head R_2 coincide with the center of the track T_5, the center of the recording head W_3 and that of the reproducing head R_3 coincide with the center of the track T_9 and the center of the recording head W_4 and that of the reproducing head R_4 coincide with the center of the track T_{13}.

In this state, the magnetic tape 21 is moved in the direction X when data is recorded so that data is simultaneously recorded to the tracks T_1 and T_9 by the recording heads W_1 and W_3.

After data recording to a lengthwise end of the magnetic tape 21 has been ended, the magnetic tape 21 is moved in the direction - X so that data is simultaneously recorded to the tracks T_5 and T_{13} by the recording heads W_2 and W_4. After data recording to a lengthwise end of the magnetic tape 21 has been ended, the combination head 23 is moved in the direction - Y by the track pitch a so that the center of the recording head W_1 and that of the reproducing head R_1 are made coincide with the center of the track T_2. Then, the magnetic tape is allowed to reciprocate in the directions X and - X while maintaining the thus realized relative position. As a result, data is recorded to the tracks T_2, T_6, T_{10} and T_{14}. Then, the combination head 23 is similarly moved by a in the direction - Y whenever the magnetic tape 21 reciprocates once. Thus, information is recorded to all of tracks T_1 to T_{16} after four times of the reciprocating motions have been completed.

Since the above-described serpentine system multi-track magnetic recording/reproducing apparatus is constituted in such a manner that data is recorded/reproduced from a multiplicity of tracks by moving a reduced number of magnetic heads in the widthwise direction of the tape. Therefore, the track pitch can be reduced and the number of the tracks can thereby be increased by arranging the structure in which the magnetic head is moved by a multiplicity of times. Therefore, the thin film head can be integrated smoothly.

As the head tape relative position restricting means of the serpentine system multi-track magnetic recording/reproducing apparatus, a head positioning technology has, as disclosed in, for example, Japanese Patent Laid-Open No. 62-183019, been known in which the stepping motor is open-loop-controlled in addition to the restriction performed by the above-described flanges.

However, in the serpentine system magnetic recording/reproducing apparatus in which the track pitch is several tens of micromillimeters, the track width becomes, of course, several tens of micromillimeters. Therefore, the offtrack becomes a l vel of ten to several micromillimeters. However, the tape head relative position restricting means arranged in such a manner that the above-described open-loop control is performed cannot correspond to the small above-described allowable offtrack.

In a case where th total stroke of the combination head of the above-described serp ntin system magnetic recording/reproducing apparatus is about 1 mm at the time of switching the track, the servo reproducing head must have a relatively large dynamic range of about 60 dB in order to reduce the tracking residual error to be smaller than 1 μm.

However, the conventional method in which one servo track is traced by two servo heads encounters a problem in that satisfactory S/N ratio and linearity cannot b obtained in overall region of the larg dynamic range. Therefore, th tracking accuracy at each track switch position has been unsatisfactory.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a tracking control device for a serpentine system magnetic recording/reproducing apparatus capable of overcoming the problems of the above-described conventional apparatuses.

The object of the invention can be achieved by each of the following devices.

A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is successively moved in the widthwise direction of a magnetic tape for switching tracking positions so that data recording/reproducing is, by each of said plurality of magnetic heads, performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising :

at least two servo signal reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use from a plurality of servo tracks formed in parallel to said data tracks on said magnetic tape ; and

movement control means for controlling, at each of said tracking positions, movement of said head unit in said widthwise direction in accordance with the difference in two servo signals reproduced by adjacent two of said servo signal reproducing heads corresponded to said each of said tracking positions, wherein

a pitch of said servo tracks is an integral multiple of a pitch of said data tracks, the number of said servo tracks is the same or smaller than the number of said tracking positions to be switched and said servo signal reproducing heads are disposed at substantially the same pitch as said pitch of said data tracks in said widthwise direction.

A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is successively moved in the widthwise direction of a magnetic tape for switching tracking positions so that data recording/reproducing is, by each of said plurality of magnetic heads, performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising :

servo signal reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use from a servo track formed in parallel to said data tracks on said magnetic tape ; and

movement control means for controlling, at each of said tracking positions, movement of said head unit in said widthwise direction in accordance with the difference in two servo signals reproduced by adjacent two of said servo signal reproducing heads corresponded to said each of said tracking positions, wherein

the number of said servo signal reproducing heads is larger than, by one, the number of said tracking positions to be switched and said servo signal reproducing heads are, in said widthwise direction, disposed at substantially the same pitch as a pitch of said data tracks.

A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is successively moved in the widthwise direction of a magnetic tape for switching tracking positions so that data recording/reproducing is, by each of said plurality of magnetic heads, performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising :

servo signal reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use recorded along one end portion of said magnetic tape with respect to said widthwise direction ; and

movement control means for controlling, at each of said tracking positions, movement of said head unit in said widthwise direction in accordance with the difference between a level of a servo signal reproduced by one of said servo signal reproducing heads corresponded to said each of said tracking positions and a level of a predetermined reference signal, wherein

the number of said servo signal reproducing heads is the same as the number of said tracking positions to be switched and said servo signal reproducing h ads are, in said widthwise direction, disposed at substantially the sam pitch as a pitch of said data tracks.

A tracking control device for a magnetic recording/reproducing apparatus having a combination head including magnetic heads the number of which is smaller than the number of data tracks formed on said magnetic tape in parallel to a direction in which a magnetic tape moves and being arranged to perform data recording/reproducing along said data tracks by successively moving said combination head in said widthwise

direction for switching tracking positions, said tracking control device comprising :

reflecting typ photointerrupters each of which is provided integrally with said combination head so as to confront one of widthwise ends of said magnetic tape at corresponding one of said tracking positions for generating a signal which denotes intensity of light reflected from said magnetic tape ;

movement control means for controlling, at each of said tracking positions, movement of said combination head in said widthwise direction in accordance with the difference between a level of a signal generated by one of said reflecting type photointerrupters which confronts said one of said widthwise ends and a level of a predetermined reference signal, wherein the number of said reflecting type photointerrupters is the same as the number of said tracking positions to be switched and said reflecting type photointerrupters are disposed at substantially the same pitch as a pitch of said data tracks in said widthwise direction.

According to the present invention, it is possible to provide a serpentine high density magnetic recording/reproducing apparatus capable of recording/reproducing information from tracks formed on a magnetic tape at a pitch of several tens of microns.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a tracking control device of a conventional serpentine system magnetic recording/reproducing apparatus ;

Figs. 2A and 2B illustrate a first embodiment of a tracking control apparatus according to the present invention ;

Fig. 3 is a block diagram which illustrates drive means of a tracking control device according to the first embodiment ;

Figs. 4A and 4B illustrate a modification to the first embodiment of the tracking control device ;

Figs. 5A and 5C illustrate a second embodiment of the tracking control device according to the present invention ;

Fig. 5B is a block diagram of a drive means of the tracking control device according to the second embodiment ;

Fig. 6 illustrates a modification to the second embodiment of the tracking control device ;

Figs. 7A and 7C illustrate a third embodiment of the tracking control device according to the present invention ;

Fig. 7B is a block diagram of a drive means of the tracking control device according to the third embodiment ;

Fig. 8A illustrates a first modification to the third embodiment of the tracking control device ;

Fig. 8B is a block diagram of a drive means of the tracking control device according to a first modification ;

Fig. 9 illustrates a second modification to a third embodiment of the tracking control device ;

Fig. 10 illustrates a third modification to the third embodiment of the tracking control device ;

Fig. 11 illustrates a fourth embodiment of the tracking control device according to the present invention ;

Fig. 12 is a block diagram of a drive means of the tracking control device according to a the fourth embodiment ;

Fig. 13 illustrates a first modification to the fourth embodiment of the tracking control device ; and

Fig. 14 illustrates a second modification to the fourth embodiment of the tracking control device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of the present invention will now be described with reference to Figs. 2A, 2B and 3.

A magnetic recording/reproducing apparatus according to the first embodiment is used to serve as a backup storage device for, for example, a hard disk apparatus. The above-described apparatus employs a serpentine method which enables information to be recorded/reproduced from each of tracks by successively moving magnetic heads of the number which is smaller than the number of the tracks of the magnetic tape in the widthwise direction of the magnetic tape.

As shown in Fig. 2A, the magnetic recording/reproducing apparatus comprises, as a head unit, a combination head 3 having recording heads W1 to W8 and reproducing h ads R1 to R8 (partially illustrated) which are formed as thin film heads on a pair of substrates 2a and 2b extending in direction Y which is the widthwise direction of a magnetic tape 1, th substrates 2a and 2b being adhered to each other. The combination head 3 can be moved in the directi n Y or - Y by a drive means such as a voice coil type linear motor 17 (see Fig. 3).

As a magnetic tape 1, for example, a quarter-inch-wide tape is used. The magnetic tape 1 has 48 data tracks T1 to T48 extending in the direction Y and in parallel to the direction in which the magn tic tape 1 moves (in direction X), the magnetic tape 1 being formed at a pr determined track pitch (for example, 120 μm). As a result, information can be recorded/reproduced along the 48 data tracks T1 to T48.

The substrate 2a is arranged to have odd recording heads W1, W3, W5 and W7 and even reproducing heads R2, R4, R6 and R8 which are respectively arranged alternately. The gaps of the heads formed on the substrate 2a are positioned on a straight line designated by a dashed line A.

The substrate 2b is arranged to have odd reproducing heads R1, R3, R5 and R7 and even recording heads W2, W4, W6 and W8 which are respectively arranged alternately. The gaps of the heads formed on the substrate 2b are positioned on a straight line designated by a dashed line B.

The above-described recording heads W1 to W8 and the reproducing heads R1 to R8 are respectively arranged in the direction X which is the direction in which the magnetic tape 1 moves so that magnetic head pairs H1 to H8 are formed. The X directional positions of the recording head and the reproducing head are alternated when viewed in the adjacent two magnetic head pairs. The Y directional length of the recording heads W1 to W8 and the reproducing heads R1 to R8 are the same referring to the drawing. However, the actual apparatus is arranged in such a manner that the width of a region to which information can be recorded by each of the recording heads W1 to W8 is arranged to be slightly larger than the width of a region from which information can be reproduced by each of the reproducing heads R1 to R8.

The Y directional interval d between the adjacent magnetic head pairs is arranged to be 6c (for example, 720 μm). The drive means comprising the voice coil type linear motor 17 moves, six times, the combination head 3 in the direction Y at each track pitch, that is, performs the 6 times of the track switching operation, so that information can be recorded/reproduced from all of the data tracks T1 to T48.

A substrate 7 is positioned from a predetermined X directional distance from the substrate 2b. The substrate 7 has, at an end thereof, a servo recording portion 8 comprising six, which is the same number as that of the track switching operations, servo signal recording heads WS1 to WS6 in the direction Y. The Y directional length of each of the servo signal recording heads WS1 to WS6 and the intervals between the adjacent servo signal recording heads are respectively arranged to be the same as the pitch c of the data tracks T1 to T48.

Each of the servo signal recording heads WS1 to WS6 is arranged to cause servo tracking signals having different frequencies to be recorded to 6 servo tracks SV1 to SV6 (designated by hatched sections) positioned in the vicinity of the Y directional end of the magnetic tape 1. The frequencies of the servo signals to be recorded to the servo tracks SV1 to SV6 are arranged in such a manner that the difference in the frequencies of the servo signals to be recorded to the two adjacent servo tracks is sufficiently large as shown in Table 1.

Table 1

Servo Track	Frequency
SV1	100 KHz
SV2	10 KHz
SV3	200 KHz
SV4	20 KHz
SV5	300 KHz
SV6	30 KHz

A servo reproducing portion 5 is provided in a Y directional end portion of the substrate 2a. The servo reproducing portion 5 has two servo signal reproducing heads RS1 and RS2 arranged in the direction Y at the same interval as that of the track pitch c. The Y directional length e of each of the servo signal reproducing heads RS1 and RS2 is arranged to be a value which is slightly smaller than the track pitch c, for example, the length e is arranged to be 100 μm.

The above-described servo signal reproducing heads RS1 and RS2 are positioned at a reference position

shown in Fig. 2A, that is, at positions at which th magnetic head pair H1 confronts the data track T1 so as to cover the upper portion and the lower portion of the servo track SV1 positioned at a Y directional nd portion by the same width. As a result, the levels of the signals, which are reproduced from the servo track SV1 by the servo signal reproducing heads RS1 and RS2, are made to be the same. The gap of the servo signal reproducing head RS1 and that of the servo signal reproducing head RS2 are positioned on a straight line designated by a dashed line A.

As shown in Fig. 3, the servo signal reproducing heads RS1 and RS2 are respectively connected to a comparator 14 via band pass filters (BPF) 10 and 11 and amplitude detectors 12 and 13. The BPFs 10 and 11 change their frequency characteristics for each of the servo tracks SV1 to SV6 so as to pass components having frequencies which approximate to the frequency of the servo signal among the servo signals, which have been recorded to the servo tracks SV1 to SV6, to be reproduced by the heads RS1 and RS2. Another structure may be employed in which the band pass filters 10 and 11 corresponding to the servo tracks SV1 to SV6 are selectively used.

The output from the comparator 14 is connected to a servo controller 15 the output from which is connected to the voice coil type linear motor 17 via a motor driver 16. The voice coil type linear motor 17 moves the servo reproducing portion 5 and the combination head 3 formed integrally with the servo reproducing portion 5 in the direction Y or - Y.

Although omitted from the illustration, a flange member for reducing the Y directional waving of the magnetic tape 1 to a degree about ± 20 μm by restricting the widthwise ends of the magnetic tape 1.

Information is recorded to the magnetic tape 1 in such a manner that the magnetic tape 1 is moved in the direction X so as to record information by odd recording heads W1, W3, W5 and W7 to the data tracks T1, T13, T25 and T37 while recording servo signals by the servo signal recording heads WS1 to WS6 to the servo tracks SV1 to SV6 at frequencies shown in Table 1 or the same has been recorded. At this time, recorded information is immediately reproduced by the odd reproducing heads R1, R3, R5 and R7 to validate its contents. If there is an error, information is again recorded.

At this time, the servo signal is reproduced from the Y directional end servo track SV1 by two servo signal reproducing heads RS1 and RS2. The comparator 14 compares the amplitude of the signals reproduced by the servo signal reproducing heads RS1 and RS2 via band pass filters 10 and 11 which pass only the components in the vicinity of 100 KHz which is the frequency of the servo signal of the servo track SV1 and the amplitude detectors 12 and 13. The servo controller 15 rotates the voice type linear motor 17 via the motor driver 16 in accordance with the output from the comparator 14 so that the amplitude of the signal reproduced by the servo signal reproducing head RS1 and that reproduced by the servo signal reproducing head RS2 are made to be same. As a result, the combination head 3 is moved in the direction Y or - Y. Therefore, the odd number recording heads W1, W3, W5 and W7 follow the corresponding data tracks T1, T3, T25 and T37.

After information has been recorded to the X directional end along the data tracks T1, T13, T25 and T37, the magnetic tape is moved in the - X direction, information is recorded to data tracks T7, T19, T31 and T43 by even number recording heads W2, W4, W6 and W8. At this time, recorded information is immediately reproduced by the even reproducing heads R2, R4, R6 and R8 to validate its contents. Also at this time, the servo signal is reproduced from the servo track SV1 by the servo signal reproducing heads RS1 and RS2 so that the tracking control is similarly performed. Since the servo signals have been recorded to the servo tracks SV1 to SV6 in the forward movement of the magnetic tape 1, it is not necessary.

When the information recording operation reaches the - X directional end, the combination head 3 is moved in the - Y direction by the track pitch c as shown in Fig. 2B. As a result, information is recorded to the data tracks T2, T14, T26 and T38 by the odd recording heads W1, W3, W5 and W7 while moving the magnetic tape 1 in the direction X. At this time, the servo signal is reproduced from the servo track SV2 by the servo signal reproducing heads RS1 and RS2. In order to make the signals reproduced by the servo signal reproducing heads RS1 and RS2, tracking is performed by moving the combination head 3 in the direction Y or - Y by the voice coil type linear motor 17. At this time, the frequency characteristics of the band pass filters 10 and 11 are changed to the characteristics which allows only the components to pass, the components having the frequencies which are near 10 KHz which is the frequency of the servo signal of the servo track SV2. As an alternative to this, the BPFs 10 and 11 provided exclusively for the servo track SV2 may be selected.

When the information recording operation reaches the X directional end, the magnetic tape 1 is moved in the direction - X. As a result, information is recorded to the data tracks T8, T20, T32 and T44 by th ven recording heads W2, W4, W6 and W8 while performing tracking in accordance with the outputs from the servo signal reproducing heads RS^1 and RS^2. Also at this time, the tracking is performed by the servo track SV2.

Then, the track is switched six times by combining, as shown in Tabl 2, the recording heads W1 to W8 and the data tracks T1 to T48 while similarly moving the combination head 3 in th direction - Y by the distance corresponding to the track pitch c whenever the magnetic tape 1 reciprocates and changing the subject servo

track to th adjacent track when viewed in the direction - Y. As a result, information is recorded to all of the data tracks T1 to T48.

Table 2

	Forward Passage	Reverse Passage
Track Switch I (SV1 is used)	W1-T1, W3-T13 W5-T25, W7-T37	W2-T7, W4-T19 W6-T31, W8-T43
Track Switch II (SV2 is used)	W1-T2, W3-T14 W5-T26, W7-T38	W2-T8, W4-T20 W6-T32, W8-T44
Track Switch III (SV3 is used)	W1-T3, W3-T15 W5-T27, W7-T39	W2-T9, W4-T21 W6-T33, W8-T45
Track Switch IV (SV4 is used)	W1-T4, W3-T16 W5-T28, W7-T40	W2-T10, W4-T22 W6-T34, W8-T46
Track Switch V (SV5 is used)	W1-T5, W3-T17 W5-T29, W7-T41	W2-T11, W4-T23 W6-T35, W8-T47
Track Switch VI (SV6 is used)	W1-T6, W3-T18 W5-T30, W7-T42	W2-T12, W4-T24 W6-T36, W8-T48

The reproduction mode is arranged similarly to the recording mode in such a manner that the combination head 3 is moved in the direction - Y by a distance corresponding to the track pitch c whenever the magnetic tape 1 reciprocates once. Furthermore, information is reproduced from data tracks T1 to T48 while changing the subject servo track by the servo track positioned adjacently when viewed in the direction - Y.

Although the apparatus according to the first embodiment has the servo signal recording heads WS1 to WS6, the servo signal recording heads WS1 to WS6 can be omitted from the illustration by arranging the structure in such a manner that the servo signals are previously recorded to the servo tracks SV1 to SV6 when the magnetic tape 1 is manufactured.

According to the first embodiment, the number of the track changing operations is arranged to be 6, the present invention is not limited to 6. In this case, the number of the servo tracks must be changed to correspond to the number of the track changing operations.

Then, a modification to the first embodiment will be described with reference to Figs. 4A and 4B.

According to this modification, the number of the track switching operations is arranged to be 6 similarly to the first embodiment. Furthermore, three servo signal recording heads WS1 to WS3 are provided in the servo recording portion 8 at a pitch (for example, a pitch of 240 μm) which is two times the track pitch of the data tracks T1 to T48. On the other hand, three servo signal reproducing heads RS1 to RS3 for reproducing information from the servo tracks SV1 to SV3 are provided in the servo reproducing portion 5 at a pitch (for example, 120 μm) which is the same pitch as the track pitch c. As a result, when the magnetic head pair H1 confronts the data track T1, th two servo signal reproducing heads RS1 and RS2 respectively cover the upper portion of the servo track SV1 and the lower portion of the same. The same el ments as thos according to th first embodiment are giv n the sam reference numerals and descriptions are omitted here.

Since information is, according to the thus arranged structured modification, recorded similarly to th first embodiment, only the procedure of the tracking operation will be described.

In the first reciprocation peration of the magnetic tape, that is, at the track switch position at which the

recording head W1 and the reproducing head R1 confront the data track T1, the servo reproducing heads RS1 and RS2 reproduces servo signals from the servo track SV1. Th two reproduced signals are subjected to a comparison so that the tracking is performed.

Table 3

Track Switch Position	Subject Servo Track	Servo signal Reproducing Head
I	SV1	RS1, RS2
II	SV1	RS2, RS3
III	SV2	RS1, RS2
IV	SV2	RS2, RS3
V	SV3	RS1, RS2
VI	SV3	RS2, RS3

In the second reciprocation operation, that is, at the track switch position at which the recording head W1 and the reproducing head R1 confront the data track T2, servo signal SV1 is, as shown in Fig. 4B, reproduced from the servo track SV1 by the servo signal reproducing head RS2 and RS3. The reproduced servo signal SV1 is subjected to a comparison so that tracking is performed.

Then, the third and the ensuing reciprocation operation is similarly performed in such a manner that the servo track and the servo signal reproducing head are successively switched in accordance with Table 3 so that tracking at each track switch positions is performed.

A second embodiment of the present invention will be described with reference to Figs. 5A, 5B and 5C. The same elements, which are the same as those according to the first embodiment, are given the same reference elements and their descriptions are omitted from here. As shown in Fig. 5A, a servo signal recording head WS is provided in the vicinity of the widthwise end portion of the magnetic tape 1 so as to record the servo signal to the servo track 20 (designated by hatching for convenience) formed in parallel to the data tracks T1 to T48. The gap of the servo signal recording head WS is positioned on dashed line C. The servo reproducing portion 5 has 7 servo reproducing heads RS1 to RS7 respectively arranged at same intervals which are the same as the track pitch c and in the direction Y. The number of the servo signal reproducing heads 7 is arranged to be the number which is larger than the number of the track switching operations by one. According to this embodiment, since the number of the track switching operations is arranged to be 6, seven servo reproducing heads RS1 to RS7 are provided. The servo signal reproducing heads RS1 to RS7 are positioned in such a manner that the heads RS1 and RS2 respectively cover the lower portion and the upper portion of the servo track 20 by the same widths in order to make the levels of the signals reproduced from the servo track 8 by the heads RS1 and RS2 when the recording head W1 and the reproducing head R1 confront the data track T1.

As shown in Fig. 5B, any of the outputs from the servo signal reproducing head pairs RS1/RS2, RS2/RS3,... for use at each of the track switch position is received by amplitude detectors 21 and 22. The outputs from the amplitude detectors 21 and 22 are received by a comparator 23, the output from the comparator 23 being received by a servo controller 24. The servo controller 24 acts to rotate a voice coil type linear motor 26 via a motor driver 25.

Fig. 5A illustrates a status where information is recorded or reproduced from tracks T1, T7, T13, T19, T25, T31, T37 and T43 by using heads RS1 and RS2. Fig. 5C illustrates a status where information is recorded or reproduced from tracks T2, T8, T14, T20, T26, T32, T38 and T44 by using heads RS2 and RS3. Since the recording and the reproducing operations are substantially the same as those according to the first embodiment, their descriptions are omitted here.

According to the second mbodiment, the servo signal recording head WS for recording th servo signal is provided in the servo track 20, the serv signal recording head WS can be omitted from illustration in a case where the structure is arranged in such a manner that the servo signal is previously recorded to the s rvo track 20 at the time of manufacturing th magnetic tape 1.

According to the second embodiment, th number of the track switching operations is arranged to be 6, it can optionally b arranged. In this case, the number of the servo signal reproducing heads must be arranged

to be the number which is larg r than th track switching operation by one.

The second embodiment is arranged in such a manner that the servo signal reproducing heads RS1 to RS7 are provided on the substrate 2a on which th recording and reproducing heads are provided. However, another structure may be employed which is arranged in such a manner that the servo signal reproducing heads RS1 to RS7 are provided on the substrate 2b or on another substrate except for the substrates 2a and 2b so as to be adhered to the substrates 2a and 2b.

Then, a modification to the second embodiment will be described with reference to Fig. 6.

According to this embodiment, odd servo signal reproducing heads RS1, RS3, RS5 and RS7 are disposed on the substrate 2a, while even servo signal reproducing heads RS2, RS4, RS6 are disposed on the substrate 2b. Furthermore, the gap of each of odd servo reproducing heads RS1, RS3, RS5 and RS7 is positioned on dashed line A, while the gap of each of even servo reproducing heads RS2, RS4 and RS6 is positioned on dashed line B. As a result, the degree of integration of the servo reproducing heads RS1 to RS7 can be moderated. Therefore, the servo reproducing heads RS1 to RS7 in the form of the thin film head can easily be manufactured.

A third embodiment of the present invention will be described with reference to Figs. 7A, 7B and 7C.

According to this embodiment, the same elements which are the same as those according to the first and the second embodiments are given the same reference numerals and their descriptions are omitted here.

According to the third embodiment, the servo signal recording head WS for recording the servo signal along a widthwise directional end portion 30 of the magnetic tape 1 is provided at an end portion of the substrate 7.

The servo reproducing portion 5 has 6 servo signal reproducing heads RS1 to RS6 arranged in the direction Y at intervals each of which is the same as the track pitch c. The number of the servo signal reproducing heads RS1 to RS6 is arranged to the same as the number of the track switching operation. Since the number of the track switching operation is arranged to be 6 according to this embodiment, 6 servo reproducing heads RS1 to RS6 are provided. The gaps of the servo signal reproducing heads RS1 to RS6 are positioned on a straight line designated by dashed line A.

A control means is, as shown in Fig. 7B, arranged in such a manner that a drive means 34 moves the combination head 3 in the direction Y in accordance with the outputs from the corresponding servo reproducing heads RS1 to RS6 so as to guide the magnetic head pairs H1 to H8 to the central portion of the corresponding tracks.

The control means comprises an amplitude detector 31 for detecting the amplitude of the output from any of the head among the servo signal reproducing heads RS1 to RS6 which is being used. The control means further comprises a reference amplitude voltage generator 32 for generating reference amplitude voltage and a comparator 33 for generating an error signal by comparing the output levels with each other. A drive means 34 moves the servo signal reproducing heads RS1 to RS6 and the combination head 3 in the direction Y or -Y in response to the error signal transmitted from the comparator 33. As a result, a desired track selected from the tracks T1 to T4 is followed. The drive means 34 may comprise, for example, a voice coil type linear motor.

Figs. 7A illustrates a state where information is recorded or reproduced from the tracks T1, T7, T13, T19, T25, T31, T37 and T43 by using the head RS1. Fig. 7C illustrates a state where information is recorded or reproduced from the tracks T2, T8, T14, T20, T26, T32, T38 and T44 by using the head RS2. Since the recording and reproducing operations are the same as those according to the first and the second embodiments, their description are omitted here.

According to the third embodiment, the servo signal recording head WS for recording the servo signal is provided in the servo track 20, the servo signal recording head WS can be omitted from illustration in a case where the structure is arranged in such a manner that the servo signal is previously recorded at the time of manufacturing the magnetic tape 1.

Fig. 8A illustrates a first modification of the third embodiment.

This modification is arranged in such a manner that servo signal recording heads WSa and WSb are respectively provided at the widthwise end portions of the substrate 7 so as to record the servo signals to two servo regions 30a and 30b at the widthwise end portions of the magnetic tape 1. A servo reproducing portion 5a is provided at either end portion, the servo signal reproducing portion 5a having 6 servo signal reproducing heads RS1a to RS6a which correspond to the track switching operation number 6. The 6 servo signal reproducing heads RS1a to RS6a are arranged in the widthwise direction of the magnetic tape 1 at same intervals each of which is the same as the track pitch c. On the other hand, a servo reproducing portion 5b is provided at th Y directional end portion of the magnetic tape 1, the servo signal reproducing portion 5b having 6 servo signal reproducing heads RS1b to RS6b which correspond to the number of the track switching operations. The 6 servo signal reproducing heads RS1b to RS6b are arranged in th widthwise direction of the magnetic tape 1 at same intervals each of which is the sam as the track pitch c. The servo signal reproducing heads RS1a to RS6a correspond to RS1b to RS6b so that, wh n, for exampl , RS1a is positi ned at either of th

widthwise directional ends of the magnetic tape 1, th corresponding head RS1b confront another nd of the magnetic tape 1.

According to this modification, when information is recorded to the magnetic tape 1, the servo signals are recorded to servo regions 30a and 30b at the widthwise end portions of the magnetic tape 1 by the servo signal recording heads WSa and WSb while moving the magnetic tape 1 in the direction X. Simultaneously or after the servo signal has been recorded as described above, information is recorded to the tracks T1, T13, T25 and T37 by the odd recording heads W1, W3, W5 and W7. At this time, the amplitude of the servo signal reproduced by the servo signal reproducing head RS1a and the amplitude of the servo signal reproduced by the servo signal reproducing head RS1b are respectively detected by amplitude detectors 35 and 36 (see Fig. 8B) so as to be subjected to a comparison by the comparator 33. Then, the drive means 34 performs tracking so as to make the above-described two amplitudes to be the same. Then, the track switching operations are successively performed similarly to the first embodiment so that information is recorded to all of the tracks T1 to T48. In also the reproducing mode, the track switching operation is performed and the tracking is also performed similarly to the recording mode.

Since the first modification is arranged in such a manner that the outputs from the pair of the servo signal reproducing heads are subjected to the comparison, they can be compensated to each other. Therefore, an effect can be obtained in that the tracking can accurately be performed if the magnetic characteristics of the magnetic tape 1 are changed.

A second modification of the third embodiment will be described with reference to Fig. 9. This modification is arranged in such a manner that the odd servo signal reproducing heads RS1, RS3, RS5 are disposed on the substrate 2a, while even servo signal reproducing head RS2, RS4 and RS6 are disposed on the substrate 2b. As a result, the degree of integration of the servo signal reproducing heads can be moderated so that the servo reproducing heads RS1 to RS6 in the form of the thin film head can easily be manufactured.

Fig. 10 illustrates a third modification of the third embodiment. The third modification is arranged in such a manner that the servo reproducing heads RS1a to RS6a and RS1b to RS6b according to the first modification are disposed such that the odd heads are disposed on the substrate 2a and the even heads are disposed on the substrate 2b. Similarly to this the second modification, the degree of integration of the servo signal reproducing heads can be moderated so that the combination head can easily be manufactured.

According to the third embodiment, the servo signal reproducing heads RS1 to RS6 (RS1a to RS6a and RS1b to RS6b) are disposed so as to reproduce the servo signal from the tape edge portion of the servo region 8 (8 a and 8 b). The servo signal reproducing heads RS1 to RS6 (RS1a to RS6a and RS1b to RS6b) may be disposed so as to reproduce the servo signal from the tape center portion of the servo region 8 (8a and 8b).

A fourth embodiment of the present invention will be described with reference to Figs. 11 and 12.

A tracking control device according to the fourth embodiment comprises a combination head 43 for recording/reproducing information to a magnetic tape 41. The combination head 43 has a reflecting type photointerrupter holding member 44.

The magnetic tape 41 has a track group 42 composed of 48 tracks T_1 to T_{48} formed in the direction Y at the same intervals. According to this embodiment, width C of the magnetic tape 1 is arranged to be 1/4 inch and the track pitch is arranged to be 120 μm. The waving of the magnetic tape 41 is restricted to ± 50 μm or less by flanges (omitted from illustration) which restrict the ± Y directional end portions of the magnetic tape 41.

The combination head 43 recording heads W_1 to W_{16} in the form thin films and reproducing heads R_1 to R_{16}. The recording heads W_1 to W_{16} are disposed in the direction Y at a pitch of 360 μm. The reproducing heads R_1 to R_{16} are arranged in the direction X or - X to correspond to the recording heads W_1 to W_{16}. When the magnetic tape 1 is moved in the direction X, information is recorded by 8 recording heads W_1, W_3, W_5, W_7, W_9, W_{11}, W_{13} and W_{15}. When the magnetic tape 1 is moved in the direction - X, information is recorded by 8 recording heads W_2, W_4, W_6, W_8 W_{10}, W_{12}, W_{14} and W_{16}. Furthermore, the combination head 43 is moved in the direction - Y whenever the magnetic tape 41 reciprocates once. After the magnetic tape 41 has reciprocated three times, that is after the track switching operation has been performed three times, information can be recorded/reproduced from all of the 48 tracks T_1 to T_{48}.

The reflecting type photointerrupter holding member 44 has a reflecting type photointerrupter group 45 at a position confronting either of the + Y directional end of the magnetic tape 41, the reflecting type photointerrupter group 45 being composed of three reflecting type photointerrupters Sa_1 to Sa_3. As a result, light emitted from light emitting devices La_1 to La_3 is reflected by the magnetic tape 41 so as to be detected by light receiving devices Da_1 to Da_3. The light receiving devices Da_1 to Da_3 are positioned adjacent to the magnetic tape 1 while the light emitting devices La_1 to La_3 are positioned away from the magnetic tape 1.

The number of the refl cting typ photointerrupters of the reflecting typ photointerrupter group 45 is the same as the number of the tracks (T_1 to T_3) positioned in a range in which the pair of the recording head and

th reproducing h ad, that is, the recording head W_1 and th reproducing head R_1 are able to move. Since the reflecting type photointerrupter holding member 44 is integrally formed with the combination head 43, the reflecting type photointerrupters Sa1 to Sa3 are able to move in accordance with the movement of th combination head 43 in the direction ± Y. The length e of the light emitting device is arranged to be 100 μm. The reflecting type photointerrupters Sa_1 to Sa_3 are disposed in the direction + Y at pitch d (d = 120 μm) which is the same as the track pitch of the magnetic tape 1 in such a manner that they are shifted in the direction + X so as not to overlap each other. The reflecting type photointerrupter Sa_1 is positioned in such a manner that the intermediate position between the light receiving device Da_1 of the reflecting type photointerrupter Sa_1 and the light emitting device La_1 aligns with the + Y directional end of the magnetic tape 1 when the recording head W_1 and the reproducing head R_1 are positioned to confront the track T_1.

The reflecting type photointerrupters Sa1 to Sa3 are, as shown in Fig. 12, connected to a head drive means 48 via a head drive control means 47. The head drive control means 47 comprises a reference voltage generator 49, a comparator 50 and a servo controller 51. The head drive means 48 comprises a motor driver 52 and a voice coil type linear motor 53. The comparator 50 compares the output from any of the reflecting type photointerrupters Sa_1 to Sa_3 and a predetermined reference level transmitted from the reference voltage generator 49. In order to make the difference, which is the result of the comparison, to be zero, a control signal is supplied from the servo controller 51 to the motor driver 52. As a result, the motor driver 52 rotates the voice coil type linear motor 53 so that the position of the combination head 43 is feedback-controlled. Thus, the head drive means 48 moves the combination head 43 in the ± Y direction of the magnetic head 41 so as to make the relative position between the magnetic tape 41 and the combination head 43 to be at a desired position.

When the above-described magnetic recording/reproducing apparatus reproduces data from all of the tracks T_1 to T_{48}, the combination head 43 is driven by the head drive means 48. As a result, the reproducing head R_1 and the track T_1, the reproducing head R_3 and the track T_7, the reproducing head R_5 and the track T_{13}, the reproducing head R_7 and the track T_{19}, the reproducing head R_9 and the track T_{25}, the reproducing head R_{11} and the track T_{31}, the reproducing head R_{13} and the track T_{37} and the reproducing head R_{15} and the track T_{43} respectively confront each other. At this time, the head drive control means 47 causes the head drive means 48 to move the combination head 43 so as to make the difference between the output from the reflecting type photointerrupter Sa_1 and the predetermined reference level to be zero. Furthermore, the combination head 43 is allowed to follow the waving of the magnetic tape 41 so that the relative position between the magnetic tape 41 and the combination head 43 is maintained at constant. When the magnetic tape 41 is moved in the direction X in this state, data is reproduced from tracks T_1, T_7, T_{13}, T_{19}, T_{25}, T_{31}, T_{37} and T_{43} by the reproducing heads R_1, R_3, R_5, R_7, R_9, R_{11}, R_{13} and R_{15}. After the data has been reproduced from the end of the magnetic tape 1, the magnetic tape 1 is moved in the direction - X, so that data is reproduced from the tracks T_4, T_{10}, T_{16}, T_{22}, T_{28}, T_{34}, T_{40} and T_{46} by the reproducing heads R_2, R_4, R_6, R_8, R_{10}, R_{12}, R_{14} and R_{16}.

After the data reproduction for one reciprocating operation has been completed, the combination head 43 is moved by the head drive means 48. As a result, the reproducing head R_1 and the track T_2, the reproducing head R_3 and the track T_8, the reproducing head R_5 and the track T_{14}, the reproducing head R_7 and the track T_{20}, the reproducing head R_9 and the track T_{26}, the reproducing head R_{11} and the track T_{32}, the reproducing head R_{13} and the track T_{38} and the reproducing head R_{15} and the track T_{44}, respectively confront each other. At this time, the head drive control means 47 causes the head drive means 48 to move the combination head 43 in order to make the difference between the output from the reflecting type photointerrupter Sa_2 and a predetermined reference level to be zero. When the magnetic tape 41 is moved in the direction X in this state, data is reproduced from the tracks T_2, T_8, T_{14}, T_{20}, T_{26}, T_{32}, T_{38} and T_{44} by the reproducing heads R_1, R_3, R_5, R_7, R_9, R_{11}, R_{13} and R_{15}. Then, the magnetic tape 41 is moved in the direction - X, data is reproduced from tracks T_5, T_{11}, T_{17}, T_{23}, T_{29}, T_{35}, T_{41} and T_{47}. When data is reproduced from the tracks T_3, T_9, T_{15}, T_{21}, T_{27}, T_{33}, T_{39} and T_{45} and T_6, T_{12}, T_{18}, T_{24}, T_{30}, T_{36}, T_{42} and T_{48}, the combination head 43 is moved in order to make the difference between the output from the reflecting type photointerrupter Sa_3 and a predetermined reference level to be zero. As a result, the track switching operation and the track following operation are performed so that data reproduction from all of the tracks T_1 to T_{48} is completed by the three times of the reciprocation motion of the magnetic tape 41. The recording operation is similarly performed.

Then, a first modification to the fourth embodiment of the present invention will be described with reference to Fig. 13. According to the first modification, a photointerrupter Sr for the reference output is disposed at a position which confronts a proper position of the magnetic tape 41 except for its end portion. A light receiving device Dr of the refl cting type photointerrupter Sr for the ref rence utput is disposed on the + X side while a light emitting device Lr is disposed on the - X side.

The reflecting type photointerrupter Sr for the ref rence output is provided f r the purpos of always monitoring reflection from th surface of the magnetic tape 1. In accordance with the output denoting the monitored surface reflection, the output from ach of the reflecting typ ph tointerrupter Sa_1 to Sa_3 is corrected. Therefore,

the tracking control cannot be influenced even if the output from each of the reflecting type photointerrupters Sa_1 to Sa_3 due to the chang in the reflectance or the ambient temperature.

As an alternative to the structure arranged in such a manner that the output from each of the reflecting type photointerrupters Sa1 to Sa3 in accordance with the output from the reflecting type photointerrupter Sr for the reference output, the reference level may be corrected. Furthermore, another structure may be employed in which the feedback control is performed so as to make the output from each of the reflecting type photointerrupters Sa_1 to Sa_3 to be the half of the reflecting type photointerrupter Sr for the reference output.

A second modification of the fourth embodiment will be described with reference to Fig. 14. The second modification is arranged in such a manner that a reflecting type photointerrupter group 6 composed of three reflecting type photointerrupters Sb_1 to Sb_3 is provided at positions which correspond to the - Y directional end of the magnetic tape 41 in addition to the above-described reflecting type photointerrupter group 45. The reflecting type photointerrupter Sa_1 and the reflecting type photointerrupter Sb_1 are shifted from each other by a distance which corresponds to the width of the magnetic tape 41, that is, by 1/4 inch in the direction Y. The reflecting type photointerrupters Sa1 and Sb1 are positioned in such a manner that their centers coincides with each end portion of the ± Y directional ends of the magnetic tape 1 when the recording head W_1 and the reproducing head R_1 are positioned to confront the track T_1.

The feedback control is performed in such a manner that the difference between the outputs from the reflecting type photointerrupter pairs Sa_1 and Sb1, Sa_2 and Sb_2, and Sa_3 and Sb_3 is made to be zero. As a result, the head drive means moves the combination head 43 in the ± Y direction of the magnetic tape 41 so that the relative position between the magnetic tape 41 and the combination head 43 is held at a predetermined position. The apparatus according to the second modification reveals an advantage in that an influence from the reflectance of the magnetic tape or the temperature of the reflecting type photointerrupter can be relatively prevented with respect to the apparatus according to the first modification. Furthermore, the track switching operation and the track following operation can further stably be performed.

The above-described embodiments and the modifications are arranged in such a manner that the light receiving devices Da_1 to Da_3 and Db_1 to Db_3 are positioned adjacently to the magnetic tape 41 and the light emitting devices La_1 to La_3 and Lb_1 to Lb_3 are positioned away from the magnetic tape 41. However, they may be positioned inversely.

Many widely different embodiments of the present invention may be constructed without departing from the spirit and scope of the present invention. It should be understood that the present invention is not limited to the specific embodiments described in this specification, except as defined in the appended claims.

There are described above novel features which the skilled man will appreciate give rise to advantages. These are each independent aspects of the invention to be covered by the present application, irrespective of whether or not they are included within the scope of the following claims.

Claims

1. A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is successively moved in the widthwise direction of a magnetic tape for switching tracking positions so that data recording/reproducing is, by each of said plurality of magnetic heads, performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising :

   at least two servo signal reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use from a plurality of servo tracks formed in parallel to said data tracks on said magnetic tape ; and

   movement control means for controlling, at each of said tracking positions, movement of said head unit in said widthwise direction in accordance with the difference in two servo signals reproduced by adjacent two of said servo signal reproducing heads corresponded to said each of said tracking positions, wherein

   a pitch of said servo tracks is an integral multiple of a pitch of said data tracks, the number of said serv tracks is the same or smaller than the number of said tracking positions to b switched and said servo signal reproducing heads are disposed at substantially the same pitch as said pitch of said data tracks in said widthwis direction.

2. A tracking control device according to Claim 1, wherein said servo signals are recorded on said servo tracks with different frequencies.

3. A tracking control device according to Claim 1, wherein a servo signal recording head for recording servo signals to said servo tracks is provided for said head unit.

4. A tracking control device according to Claim 1, wherein when an assumption is mad that th number of said tracking positions to be switched is n, the number of said servo tracks is ℓ and the number of said servo signal reproducing heads is m, a relationship $n = \ell \cdot (m - 1)$ is held.

5. A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is successively moved in the widthwise direction of a magnetic tape for switching tracking positions so that data recording/reproducing is, by each of said plurality of magnetic heads, performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising :

servo signal, reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use from a servo track formed in parallel to said data tracks on said magnetic tape ; and

movement control means for controlling, at each of said tracking positions, movement of said head unit in said widthwise direction in accordance with the difference in two servo signals reproduced by adjacent two of said servo signal reproducing heads corresponded to said each of said tracking positions, wherein

the number of said servo signal reproducing heads is larger than, by one, the number of said tracking positions to be switched and said servo signal reproducing heads are, in said widthwise direction, disposed at substantially the same pitch as a pitch of said data tracks.

6. A tracking control device according to Claim 5, wherein a servo signal recording head for recording servo signals to said servo tracks is provided for said head unit.

7. A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is successively moved in the widthwise direction of a magnetic tape for switching tracking positions so that data recording/reproducing is, by each of said plurality of magnetic heads, performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising :

servo signal reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use recorded along one end portion of said magnetic tape with respect to said widthwise direction ; and

movement control means for controlling, at each of said tracking positions, movement of said head unit in said widthwise direction in accordance with the difference between a level of a servo signal reproduced by one of said servo signal reproducing heads corresponded to said each of said tracking positions and a level of a predetermined reference signal, wherein

the number of said servo signal reproducing heads is the same as the number of said tracking positions to be switched and said servo signal reproducing heads are, in said widthwise direction, disposed at substantially the same pitch as a pitch of said data tracks.

8. A tracking control device according to Claim 7, wherein a servo signal recording head for recording servo signals to said servo tracks is provided for said head unit.

9. A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is successively moved in the widthwise direction of a magnetic tape for switching tracking positions so that data recording/reproducing is, by each of said plurality of magnetic heads, performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising :

a first group of servo-signal reproducing heads provided integrally with said head unit and provided for the purpose or reproducing servo signals for tracking use recorded along one end portion of said magnetic tap with respect to said widthwise direction ;

a second group of servo-signal reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use recorded along the other end portion of said magnetic tape with respect t said widthwis direction ; and

movement control means for controlling, at each of said tracking positions, movement of said head unit in said widthwise directi n in accordance with th difference between a level of a servo signal repro-

duced by one servo signal reproducing head of said first group corresponded to said each of said tracking positions and a level of a servo signal reproduced by one servo signal reproducing head of said second group corresponded to said each of said tracking positions, wherein

the number of said servo-signal reproducing heads of said first group and that of said second group are respectively the same as the number of said tracking positions to be switched and said servo-signal reproducing heads of said first group and said second group are, in said widthwise direction, disposed at substantially the same pitch as a pitch of said data tracks respectively.

10. A tracking control device according to Claim 9, wherein a servo signal recording head for recording a servo signal to said servo tracks is provided for said head unit.

11. A tracking control device for a magnetic recording/reproducing apparatus having a combination head including magnetic heads the number of which is smaller than the number of data tracks formed on said magnetic tape in parallel to a direction in which a magnetic tape moves and being arranged to perform data recording/reproducing along said data tracks by successively moving said combination head in said widthwise direction for switching tracking positions, said tracking control device comprising :

reflecting type photointerrupters each of which is provided integrally with said combination head so as to confront one of widthwise ends of said magnetic tape at corresponding one of said tracking positions for generating a signal which denotes intensity of light reflected from said magnetic tape ;

movement control means for controlling, at each of said tracking positions, movement of said combination head in said widthwise direction in accordance with the difference between a level of a signal generated by one of said reflecting type photointerrupters which confronts said one of said widthwise ends and a level of a predetermined reference signal, wherein the number of said reflecting type photointerrupters is the same as the number of said tracking positions to be switched and said reflecting type photointerrupters are disposed at substantially the same pitch as a pitch of said data tracks in said widthwise direction.

12. A tracking control device according to Claim 11, wherein each of said reflecting type photointerrupters comprises a light emitting device and a light receiving device.

13. A tracking control device according to Claim 11, wherein said reference signal is transmitted from a reflecting type photointerrupter provided for said combination unit for the purpose of detecting the intensity of light reflected from portions except for said widthwise ends of said magnetic tape.

14. A tracking control device for a magnetic recording/reproducing apparatus having a combination head including magnetic heads the number of which is smaller than the number of data tracks formed on said magnetic tape in parallel to a direction in which a magnetic tape moves and being arranged to perform data recording/reproducing along said data tracks by successively moving said combination head in said widthwise direction for switching tracking positions, said tracking control device comprising :

a first group of reflecting type photointerrupters each of which is provided integrally with said combination head so as to confront one of widthwise ends of said magnetic tape at corresponding one of said tracking positions for generating a signal which denotes intensity of light reflected from said magnetic tape ;

a second group of reflecting type photointerrupters each of which is provided integrally with said combination head so as to confront the other of said widthwise ends of said magnetic tape at corresponding one of said tracking positions for generating a signal which denotes intensity of light reflected from said magnetic tape ; and

movement control means for controlling, at each of said tracking positions, movement of said combination head in said widthwise direction in accordance with the difference between a level of a signal generated by one of said reflecting type photointerrupters of said first group which confronts said one of said widthwise ends and a level of a signal generated by one of said reflecting type photointerrupters of said second group which confronts said other of said widthwise ends, wherein

the number of said reflecting type photointerrupters of said first group and that of said second group are respectiv ly the same as the number of said tracking positions to be switched and said reflecting type photointerrupters of said first group and said second group are, in said widthwis direction, disposed at substantially the same pitch as a pitch f said data tracks respectively.

15. A tracking control device according to claim 14, wherein each of said reflecting type photointerrupters comprises a light emitting device and a light receiving device.

16. A tracking control device for a multi-track tape recording/reproducing system having a head unit which comprises a s t of magnetic heads which in use simultaneously scan along respective ones of an array of parallel data tracks extending side-by-side along a magnetic recording tape, the head unit being laterally displaceable relative to the tape to shift the set of heads between a plurality of predetermined positions for scanning respective sets of different tracks, characterised in that said tracking control device includes a servo system for controlling the lateral displacement of said head unit relative to the tape to provide tracking control in each said predetermined position, said servo system including detection means mounted for conjoint movement with the set of magnetic heads and operable in each said predetermined position for scanning one or more portions of the tape to detect tracking error, means for producing from the output or outputs of said detection means a servo signal which varies according to said tracking error, and a drive means for laterally moving the head unit in accordance with said servo signal.

17. Servo-controlled tape tracking control system for a serpentine multi-track tape recording/reproducing system in which detector heads mounted on the laterally displaceable multi-head, magnetic head unit detect a tape portion (servo track or tape edge) in each head position to enable feedback control of the head unit position.

Fig. 1

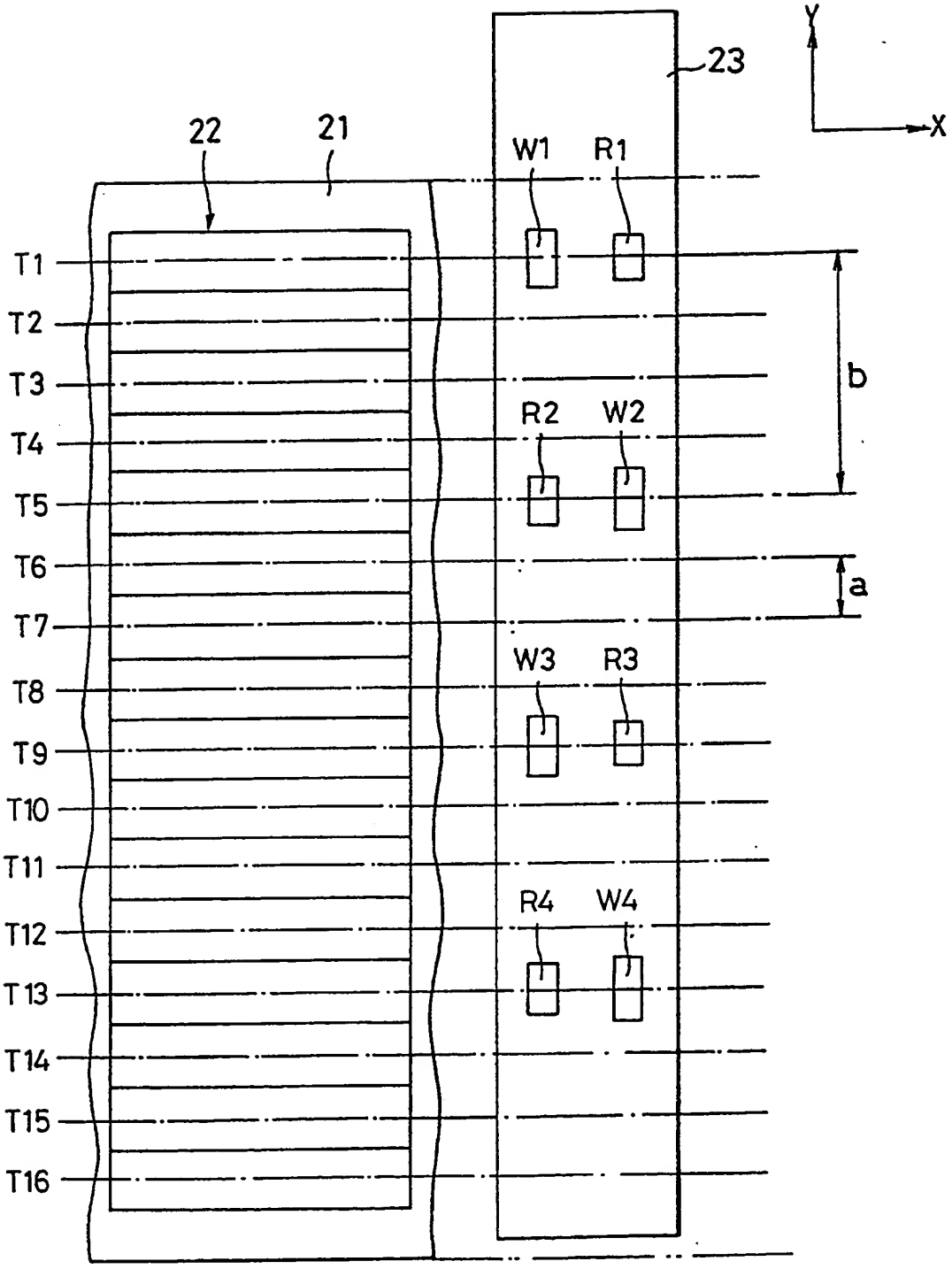
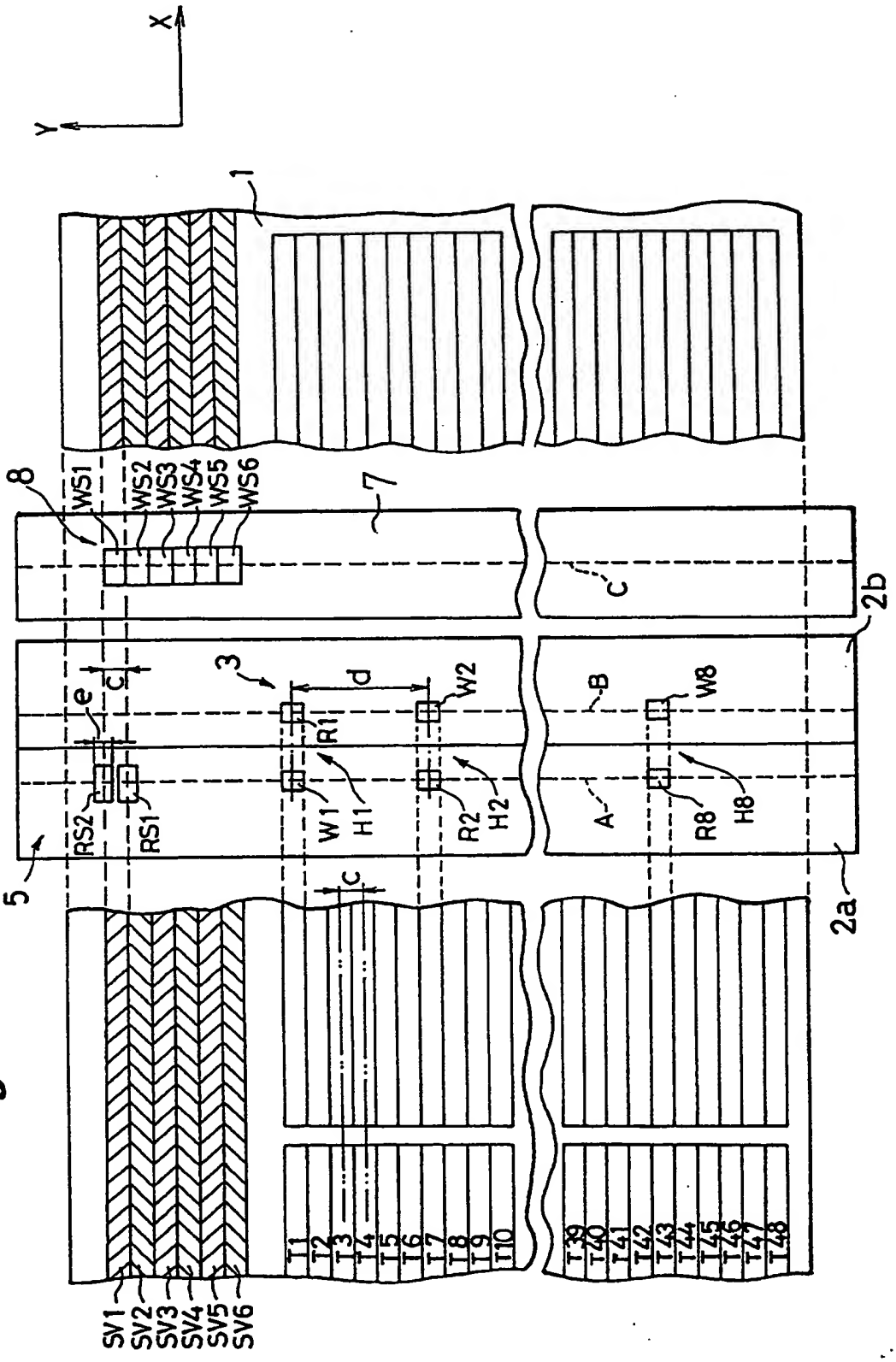

Y
X
23
22
21
W1
R1
T1
T2
T3
b
R2
W2
T4
T5
T6
a
T7
W3
R3
T8
T9
T10
T11
R4
W4
T12
T13
T14
T15
T16

Fig. 2A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Y
1
8
WS1
WS2
WS3
WS4
WS5
WS6
7
2b
2a
5
3
e
c
d
W2
R1
W1
H1
R2
H2
RS2
RS1
B
W8
A
R8
H8
c
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48
SV1
SV2
SV3
SV4
SV5
SV6

Fig. 2B

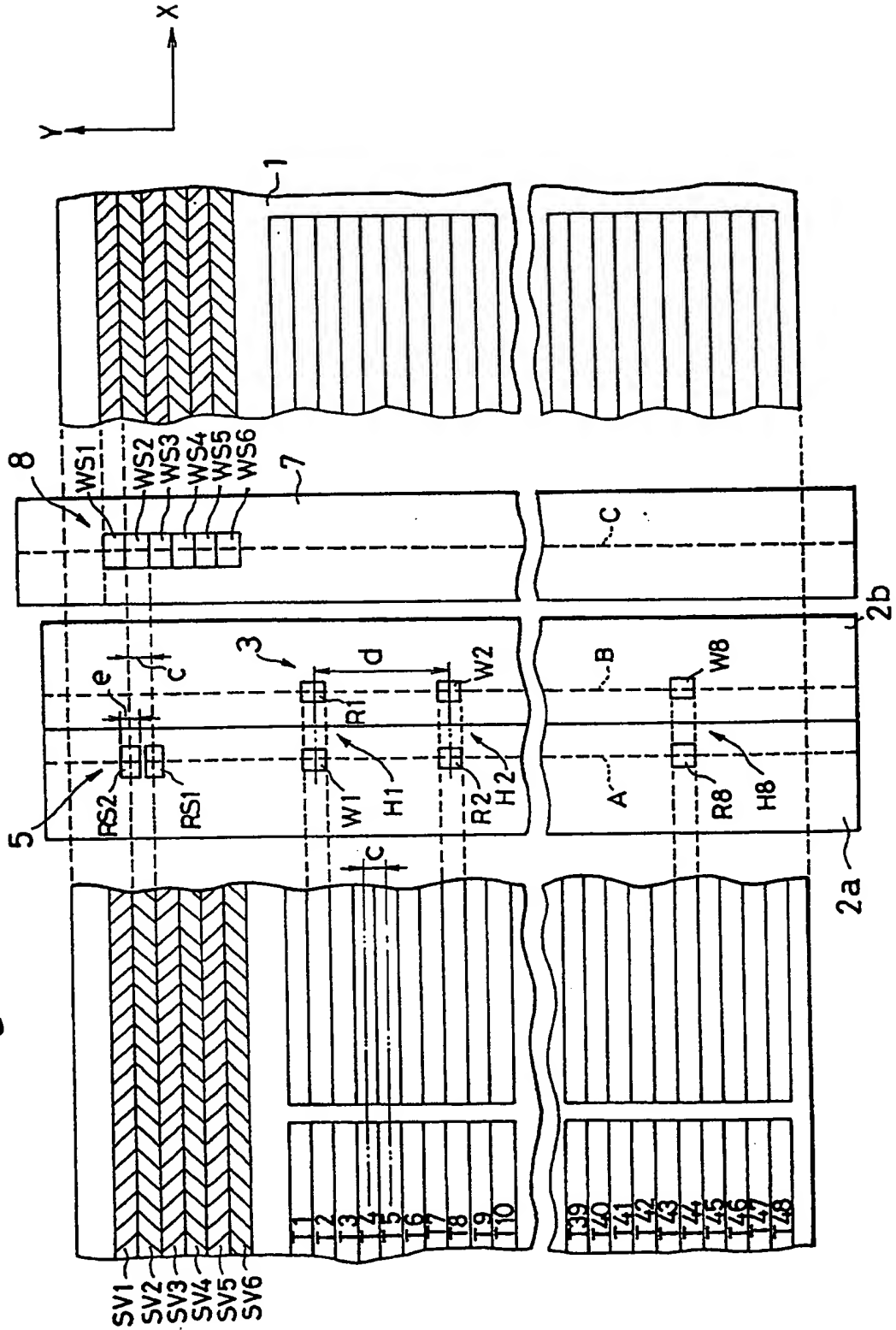
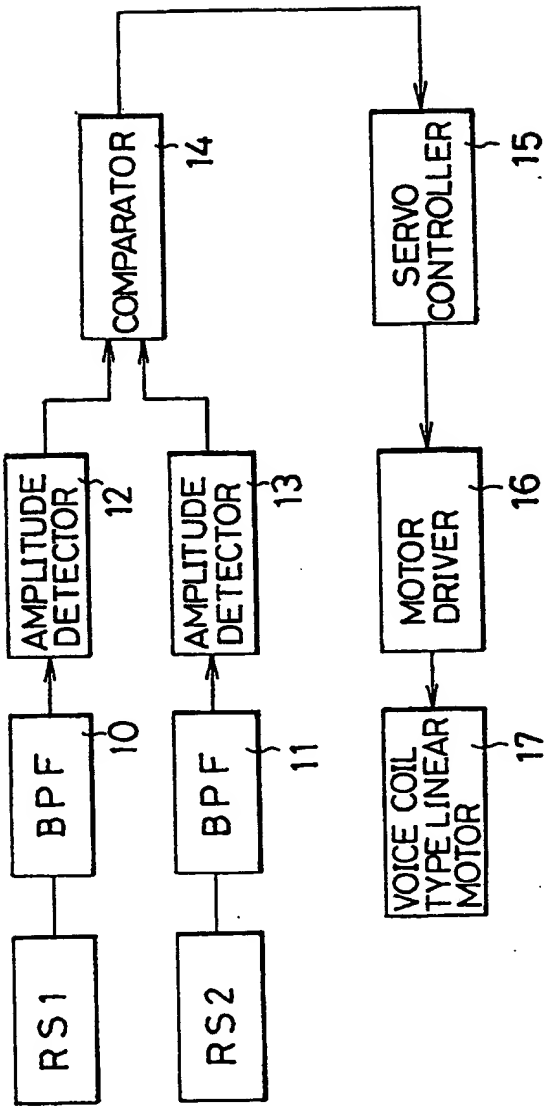

X
Y
1
8
WS1
WS2
WS3
WS4
WS5
WS6
7
C
2b
3
d
W2
e
c
R1
B
W8
5
RS2
RS1
W1
H1
R2
H2
A
R8
H8
2a
c
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48
SV1
SV2
SV3
SV4
SV5
SV6

Fig. 3


RS1
RS2
BPF
BPF
10
11
AMPLITUDE DETECTOR
AMPLITUDE DETECTOR
12
13
COMPARATOR
14
SERVO CONTROLLER
15
MOTOR DRIVER
16
VOICE COIL TYPE LINEAR MOTOR
17

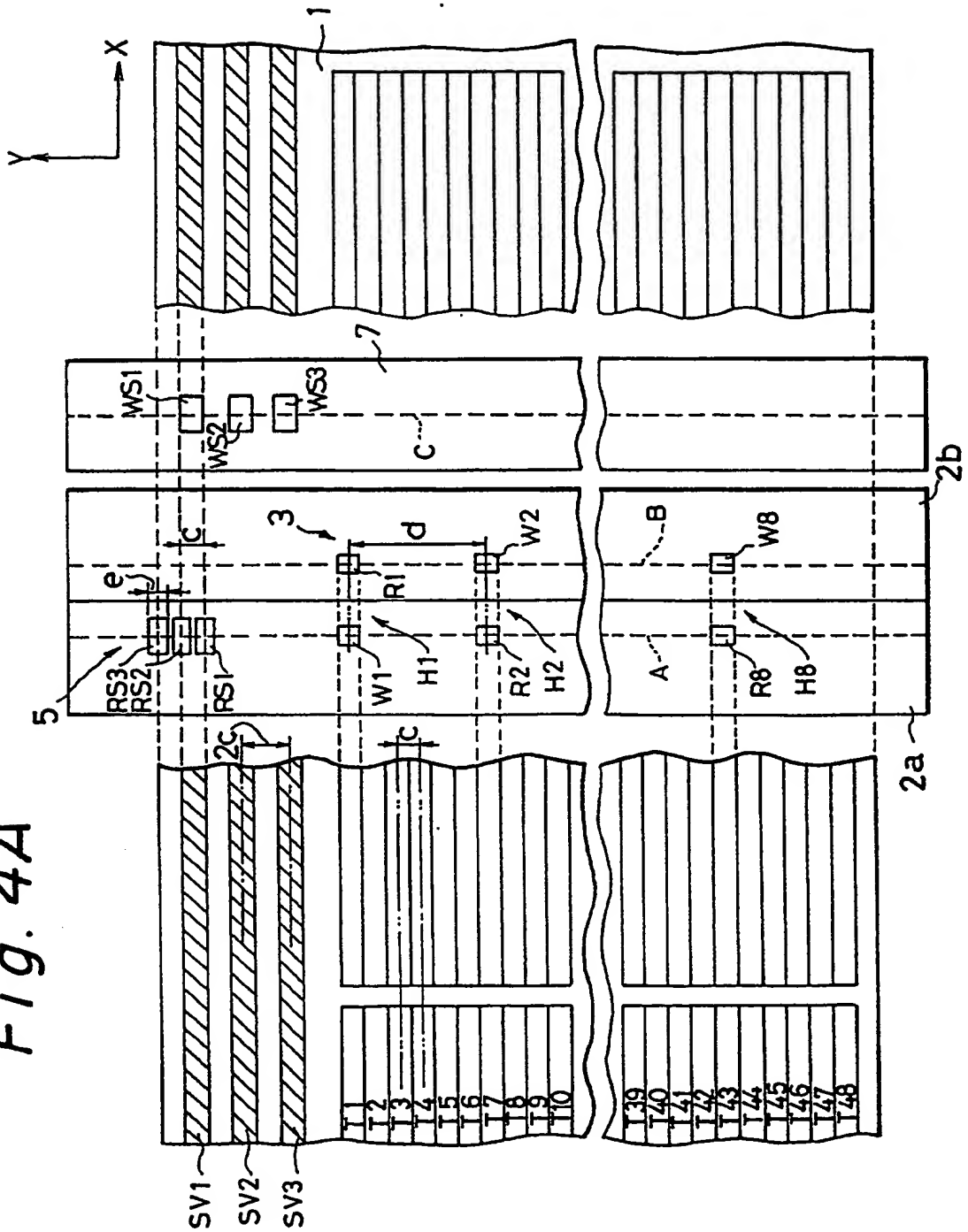

X
Y
1
7
WS1
WS2
WS3
C
2b
3
c
d
W2
e
R1
B
W8
RS3
RS2
RS1
W1
H1
R2
H2
A
R8
H8
5
2a
2c
c
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48
SV1
SV2
SV3

Fig. 4A

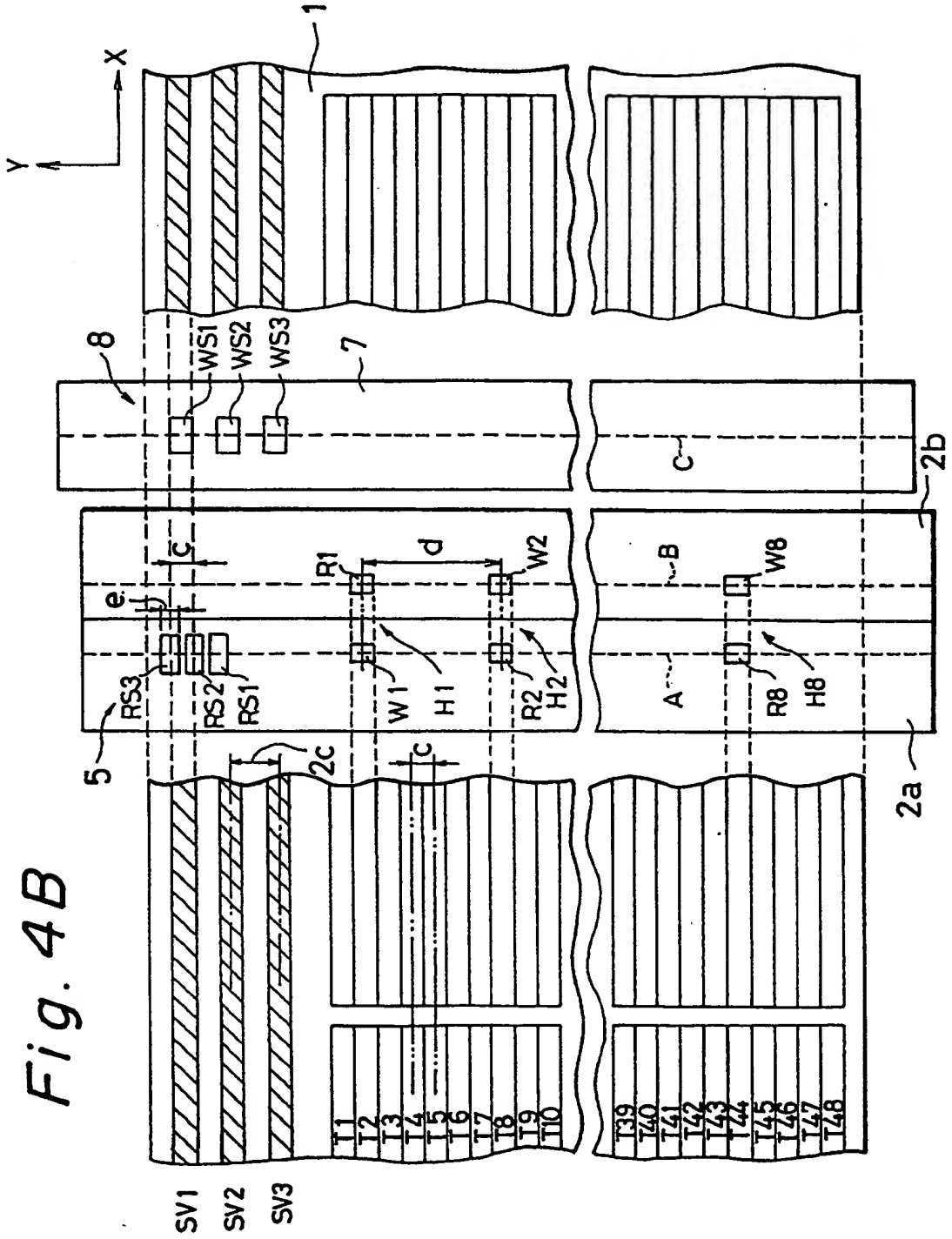

X
Y
1
8
WS1
WS2
WS3
7
C
2b
e
c
R1
d
W2
B
W8
RS3
RS2
RS1
W1
H1
R2
H2
A
R8
H8
5
2c
c
2a
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48
SV1
SV2
SV3

Fig. 4B

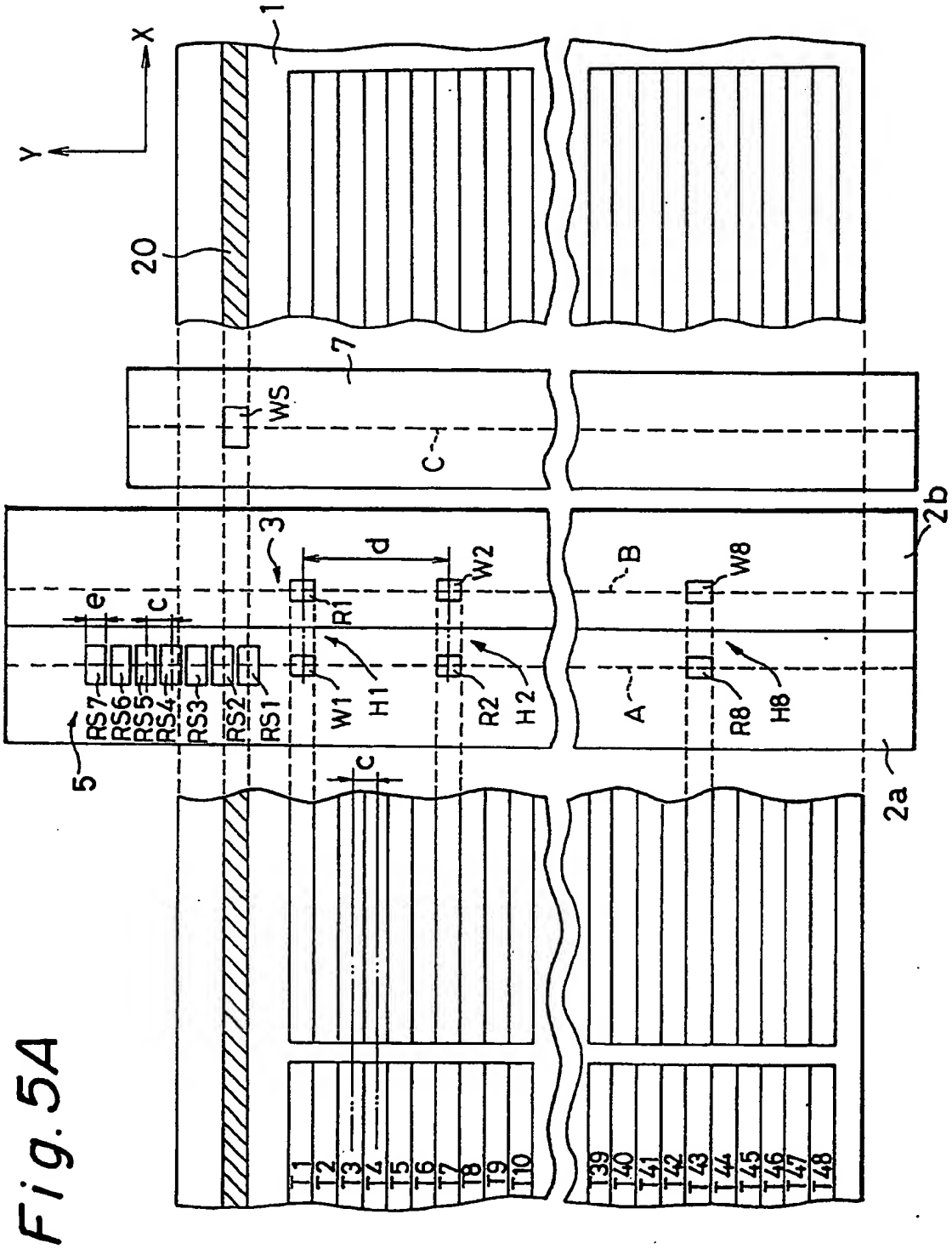
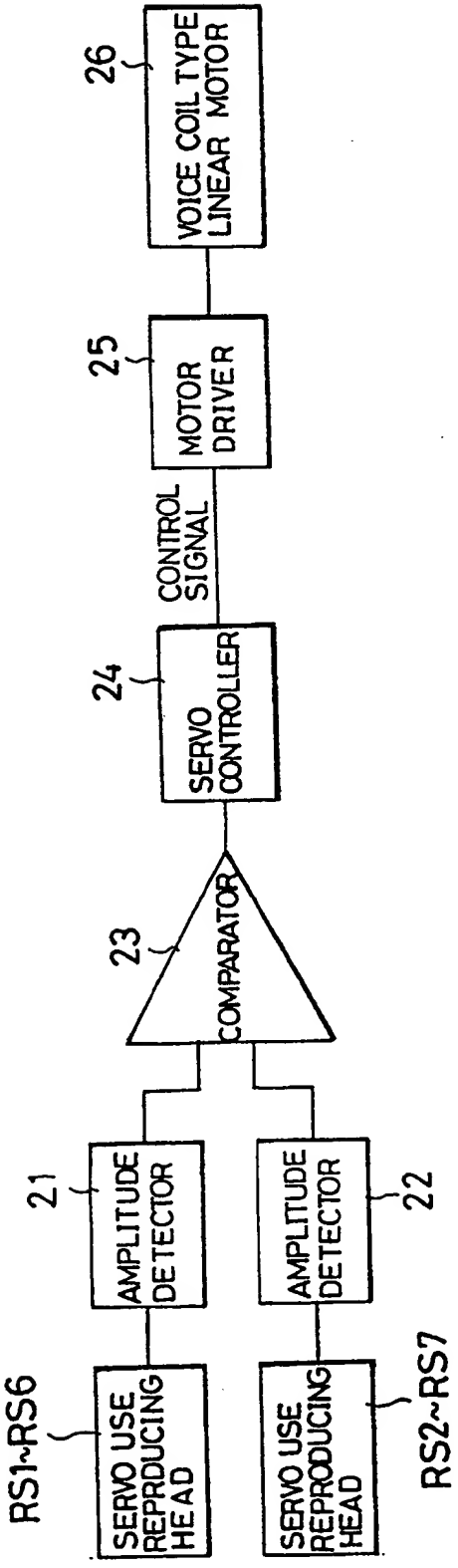

X
Y
1
20
7
WS
C
3
d
W2
B
W8
2b
e
c
R1
W1
H1
R2
H2
A
R8
H8
RS7
RS6
RS5
RS4
RS3
RS2
RS1
5
c
2a
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 5A

Fig. 5B


26
VOICE COIL TYPE LINEAR MOTOR
25
MOTOR DRIVER
CONTROL SIGNAL
24
SERVO CONTROLLER
23
COMPARATOR
21
AMPLITUDE DETECTOR
22
AMPLITUDE DETECTOR
RS1~RS6
SERVO USE REPRODUCING HEAD
SERVO USE REPRODUCING HEAD
RS2~RS7

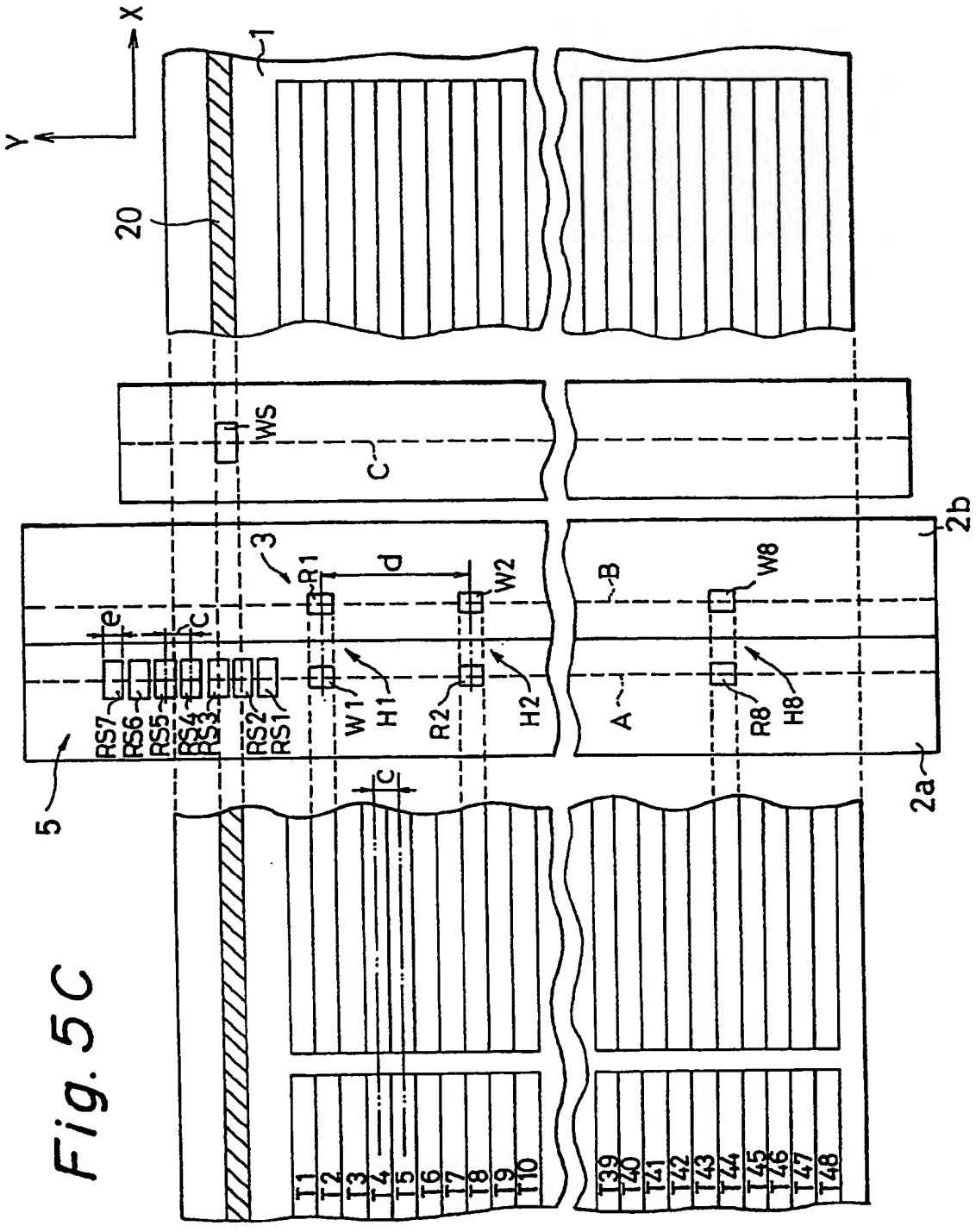

X
Y
1
20
WS
C
3
R1
d
W2
B
W8
2b
e
c
RS7
RS6
RS5
RS4
RS3
RS2
RS1
W1
H1
R2
H2
A
R8
H8
5
2a
c
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 5C

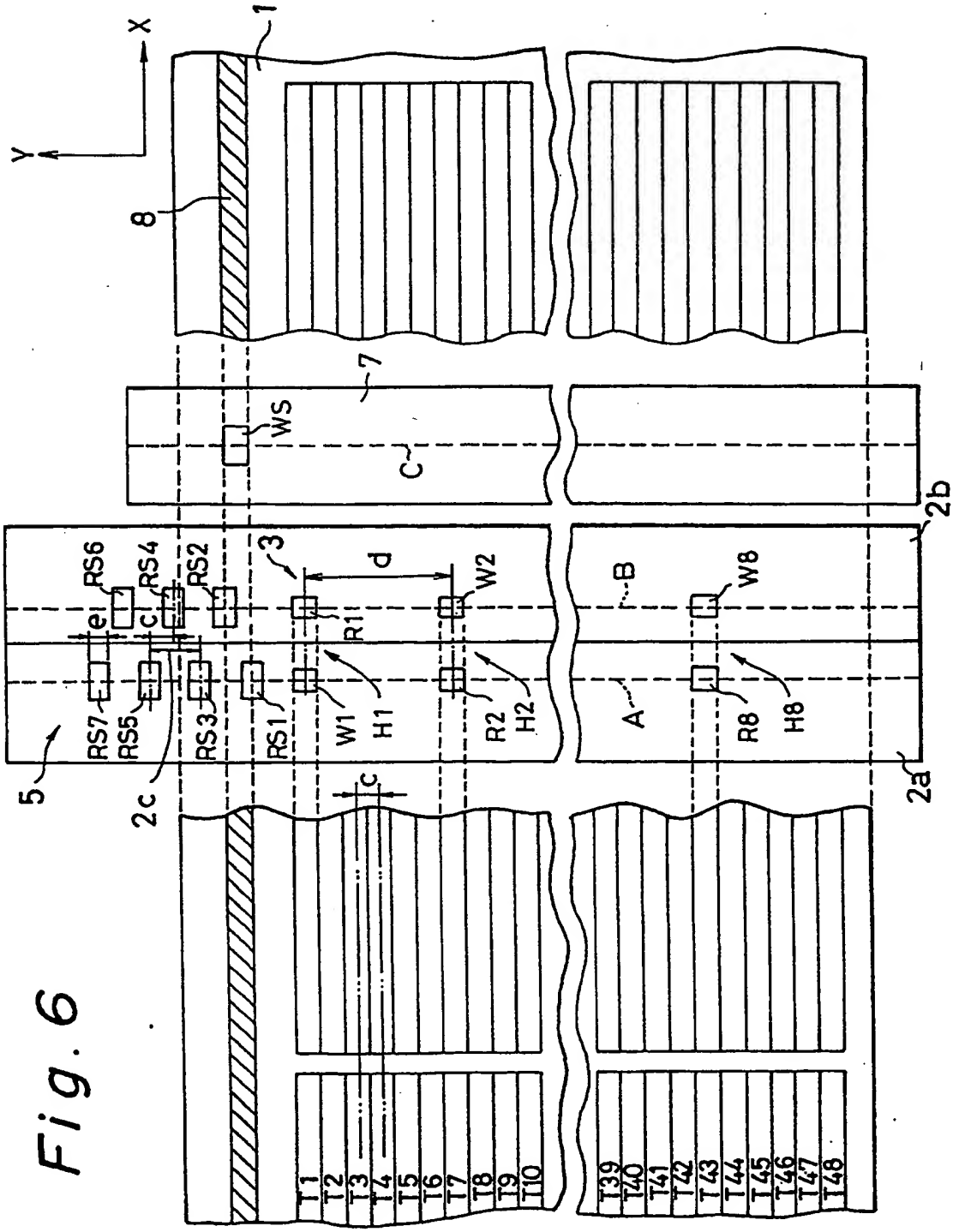
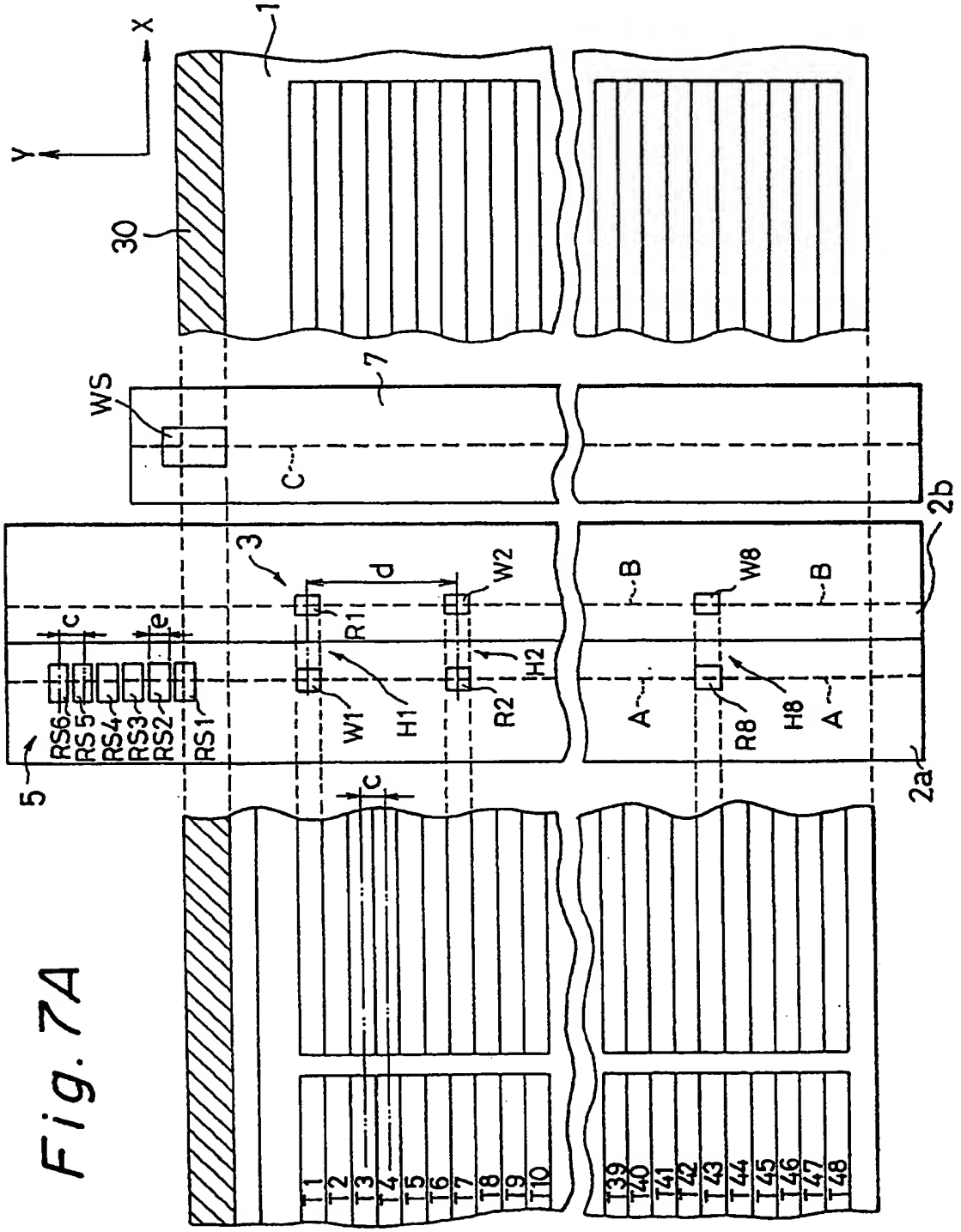

X
Y
1
8
7
WS
C
2b
3
d
W2
RS6
RS4
RS2
e
c
R1
B
W8
RS7
RS5
RS3
RS1
W1
H1
R2
H2
A
R8
H8
5
2c
2a
c
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 6


X
Y
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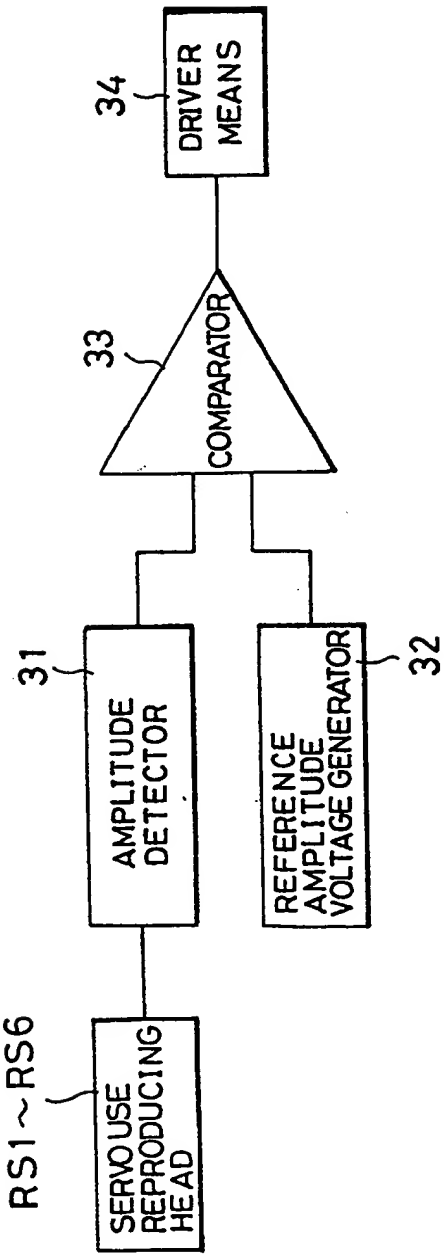
30
7
WS
C
2b
3
d
W2
R1
H2
W1
H1
R2
c
e
RS6
RS5
RS4
RS3
RS2
RS1
5
B
W8
A
R8
H8
2a
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 7A

Fig. 7B


RS1~RS6
SERVO USE REPRODUCING HEAD
31
AMPLITUDE DETECTOR
32
REFERENCE AMPLITUDE VOLTAGE GENERATOR
33
COMPARATOR
34
DRIVER MEANS

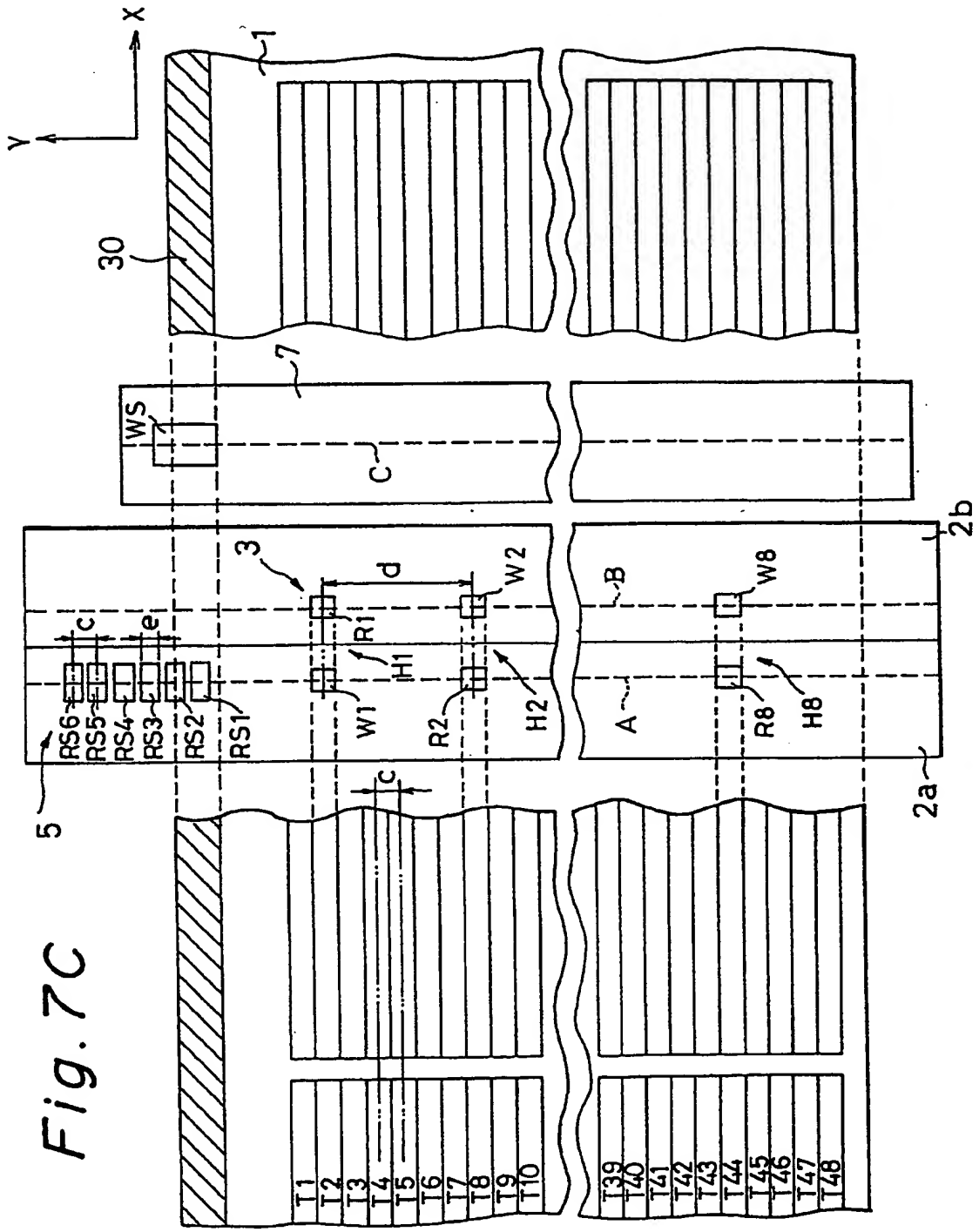
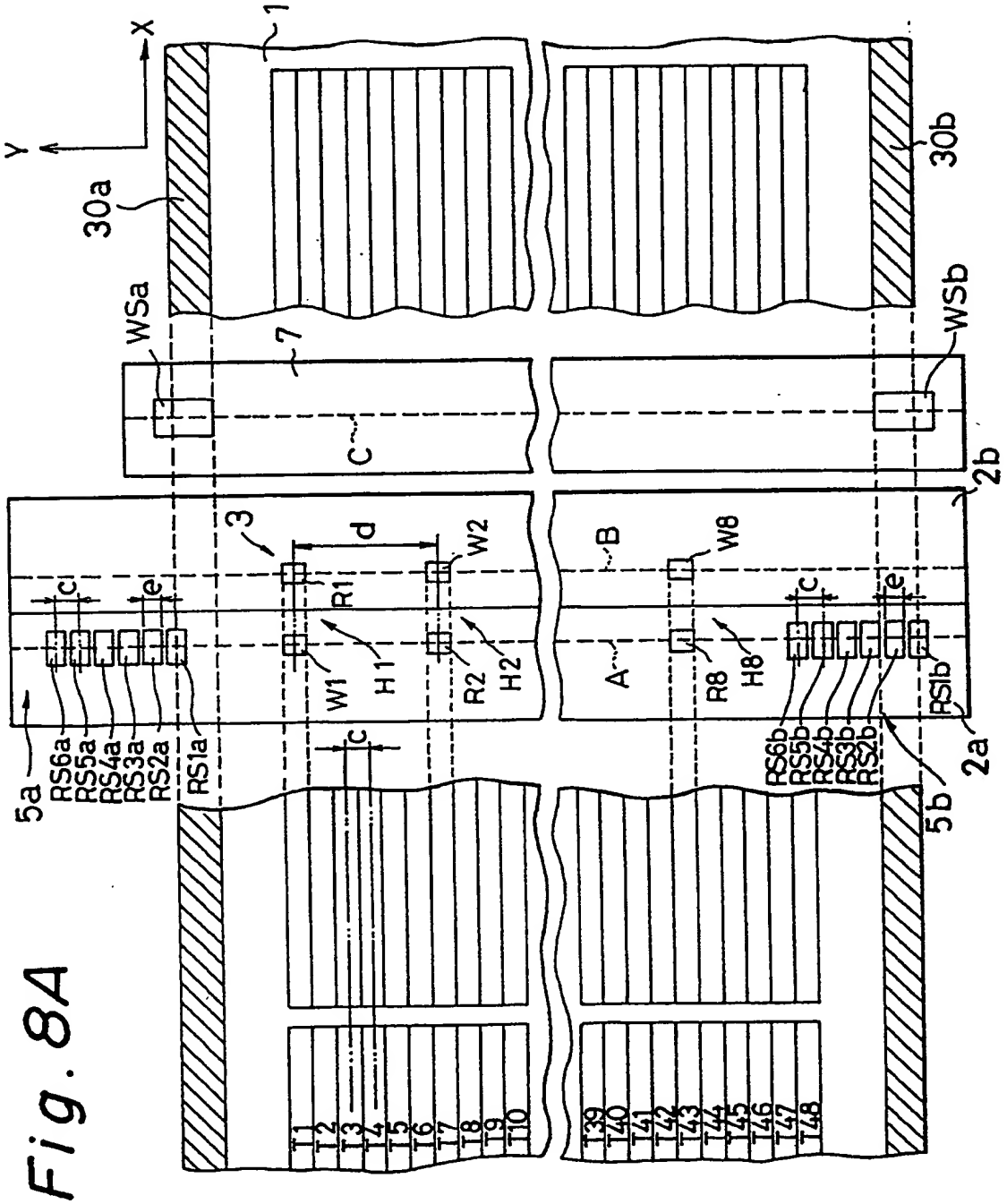

X
Y
1
30
7
WS
C
2b
3
d
W2
B
W8
c
e
R1
H1
W1
R2
H2
A
R8
H8
RS6
RS5
RS4
RS3
RS2
RS1
5
2a
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 7C


X
Y
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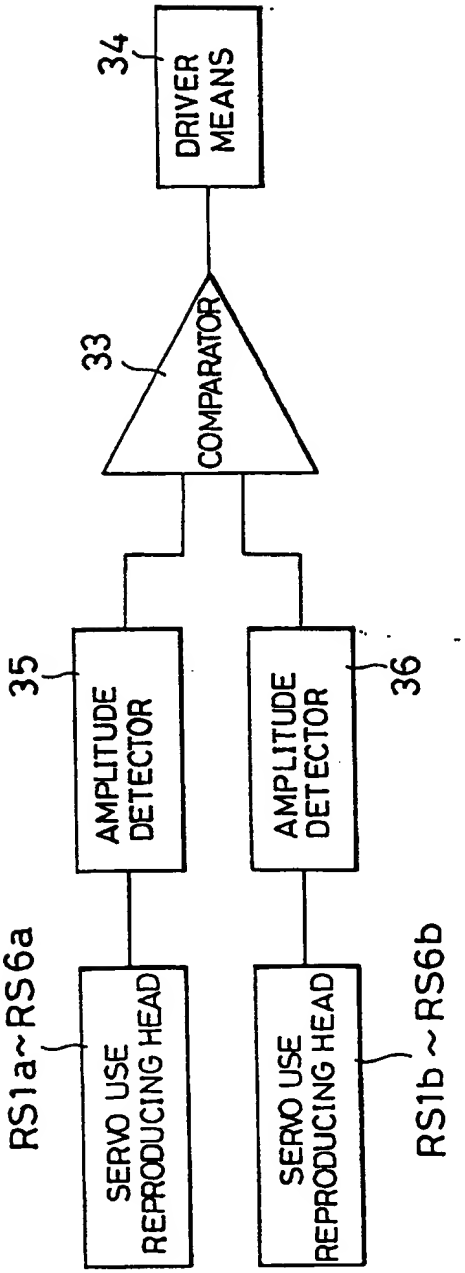
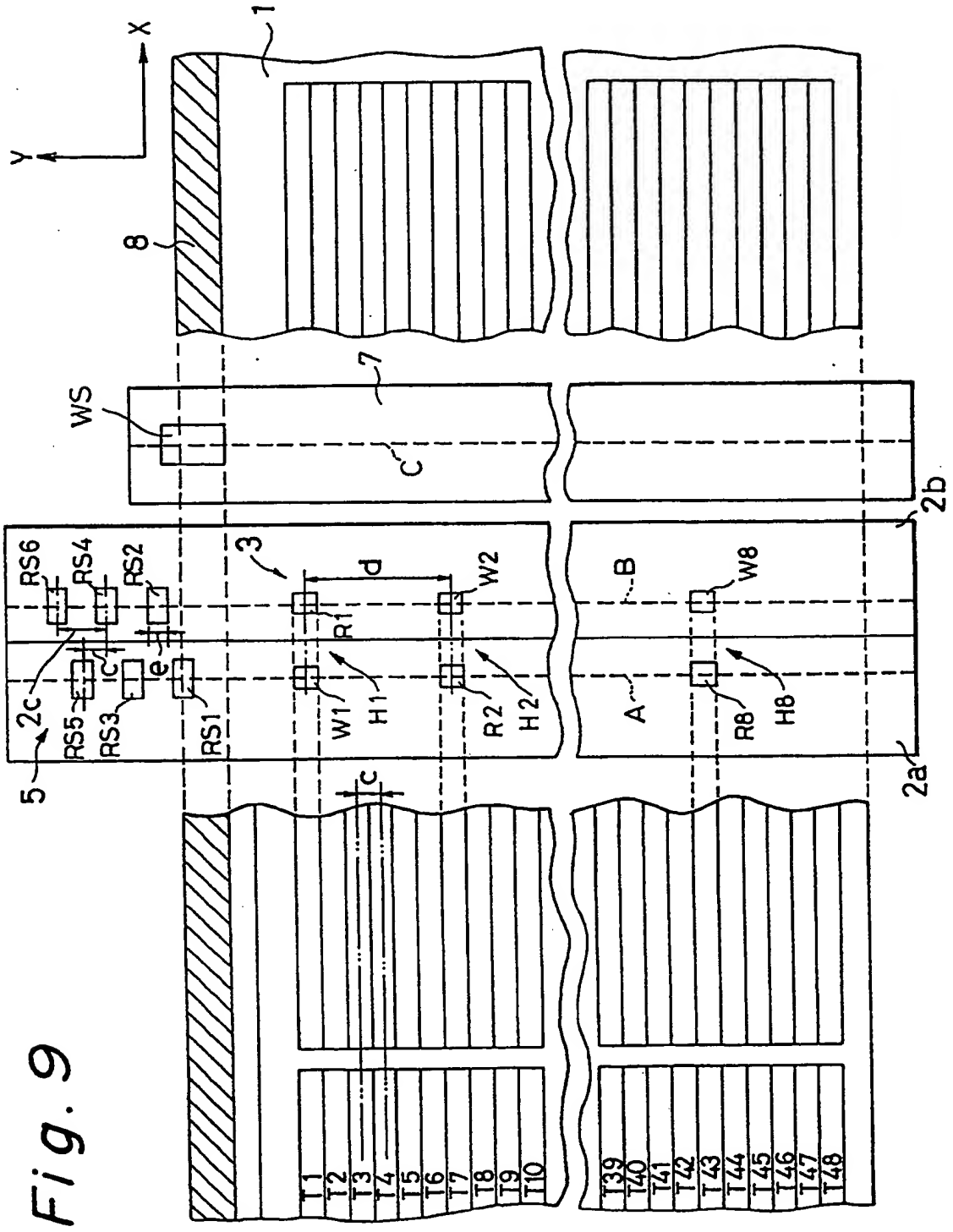
30a
30b
WSa
WSb
7
C
2b
3
d
W2
W1
H1
R1
R2
H2
B
W8
A
R8
H8
c
e
5a
RS6a
RS5a
RS4a
RS3a
RS2a
RS1a
RS1b
RS2b
RS3b
RS4b
RS5b
RS6b
2a
5b
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 8A

Fig. 8B


34
DRIVER MEANS
33
COMPARATOR
35
AMPLITUDE DETECTOR
36
AMPLITUDE DETECTOR
RS1a~RS6a
SERVO USE REPRODUCING HEAD
SERVO USE REPRODUCING HEAD
RS1b ~ RS6b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WS
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RS6
RS4
RS2
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B
W8
2c
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RS3
RS1
W1
H1
R1
R2
H2
A
R8
H8
2a
5
c
T1
T2
T3
T4
T5
T6
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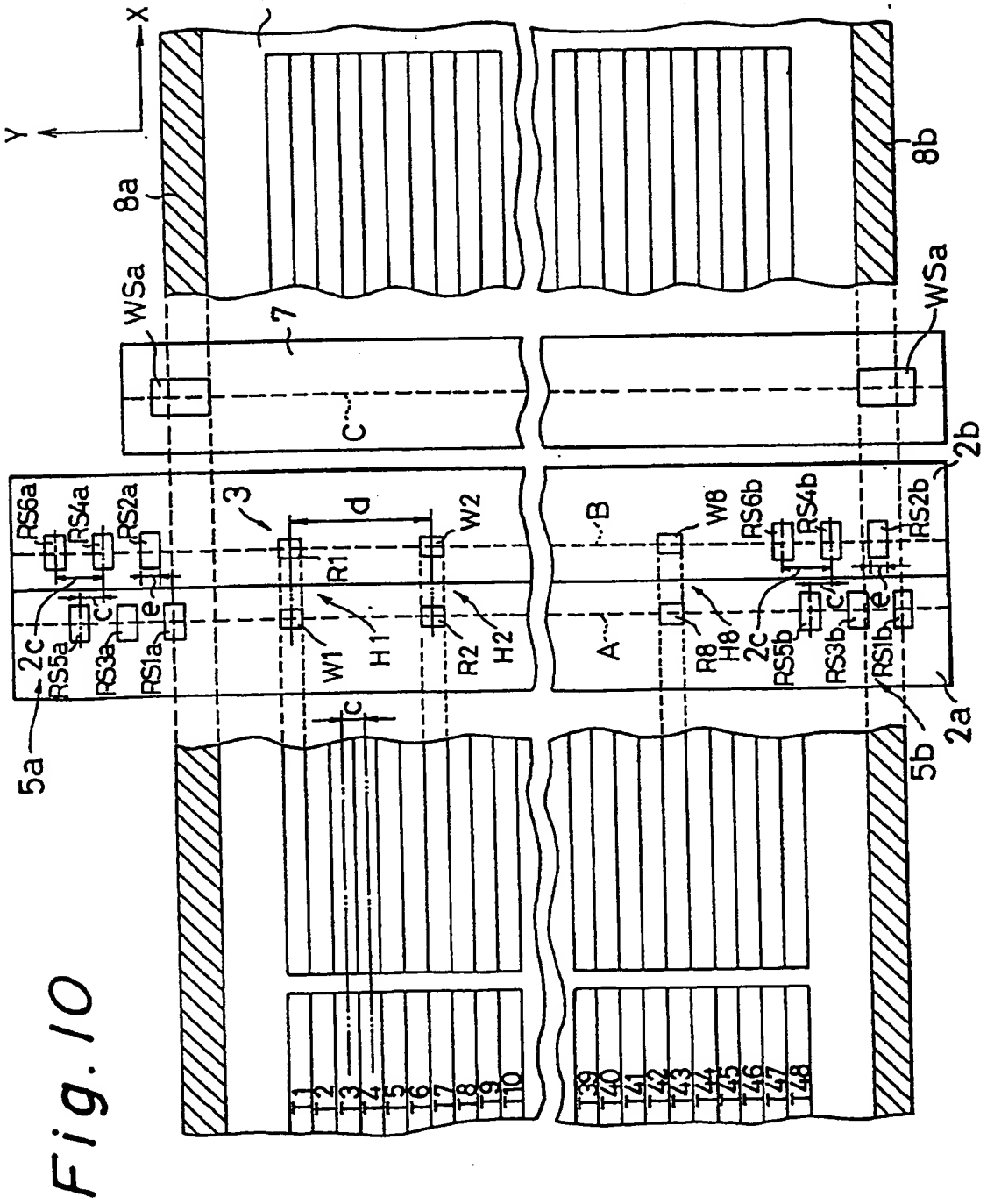
T43
T44
T45
T46
T47
T48

Fig. 9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8b
WSa
WSa
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C
2b
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R1
W1
H1
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H2
B
W8
R8
H8
A
RS6a
RS4a
RS2a
RS5a
RS3a
RS1a
2c
c
e
RS6b
RS4b
RS2b
RS5b
RS3b
RS1b
2c
5a
5b
2a
T1
T2
T3
T4
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T6
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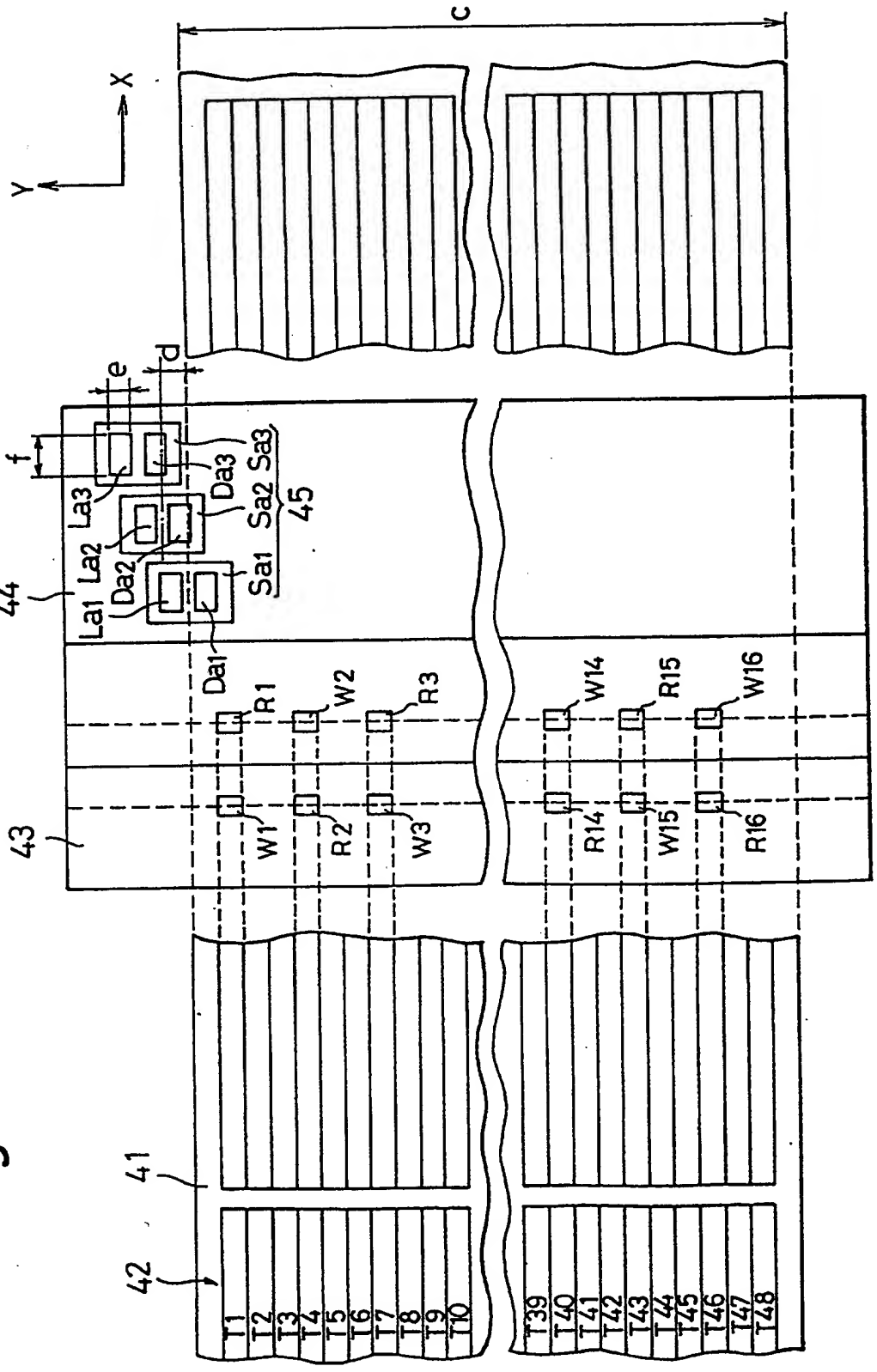
T47
T48

Fig. 10


c
X
Y
d
e
f
La3
La2
La1
Da3
Da2
Da1
Sa3
Sa2
Sa1
45
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41
42
R1
W2
R3
W14
R15
W16
W1
R2
W3
R14
W15
R16
T1
T2
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T4
T5
T6
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T47
T48

Fig. 11

Fig. 12

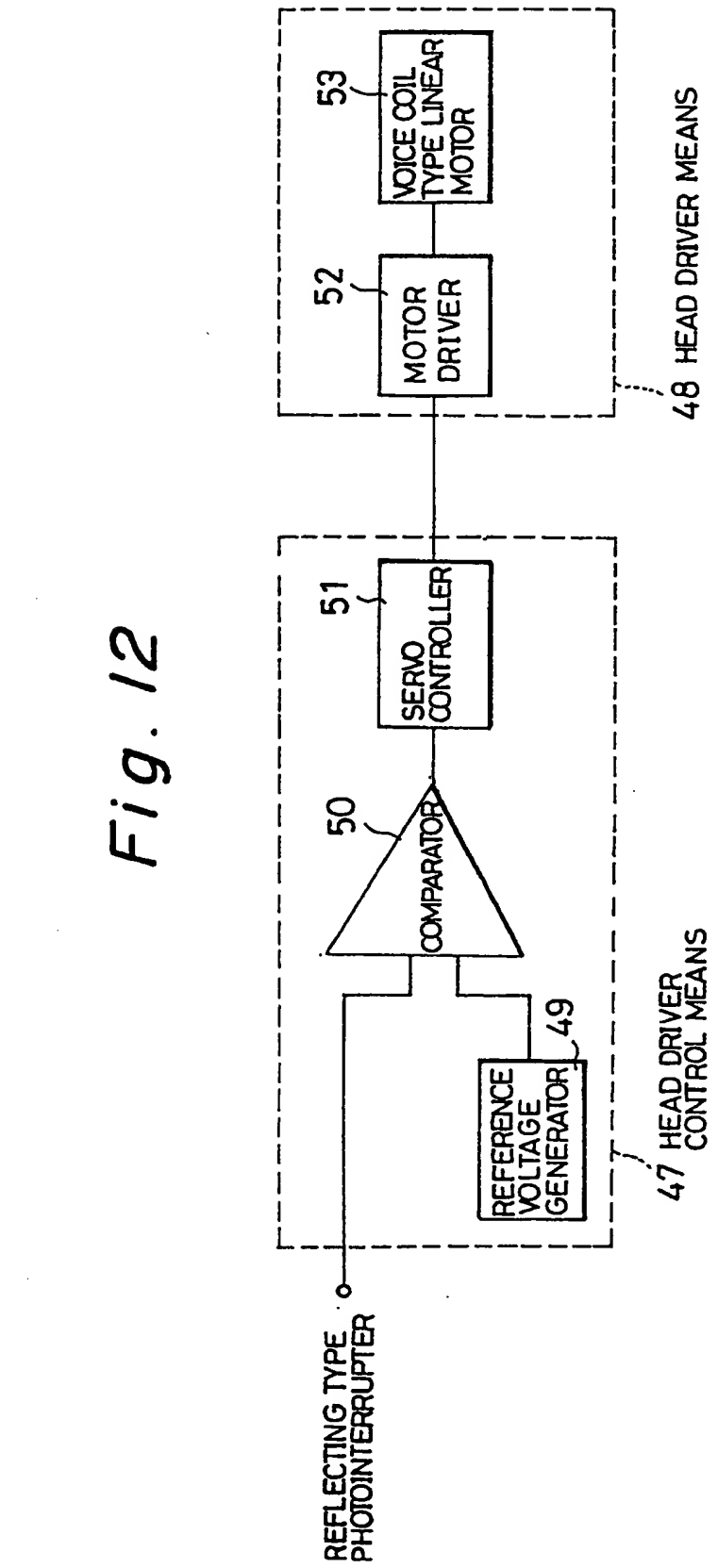
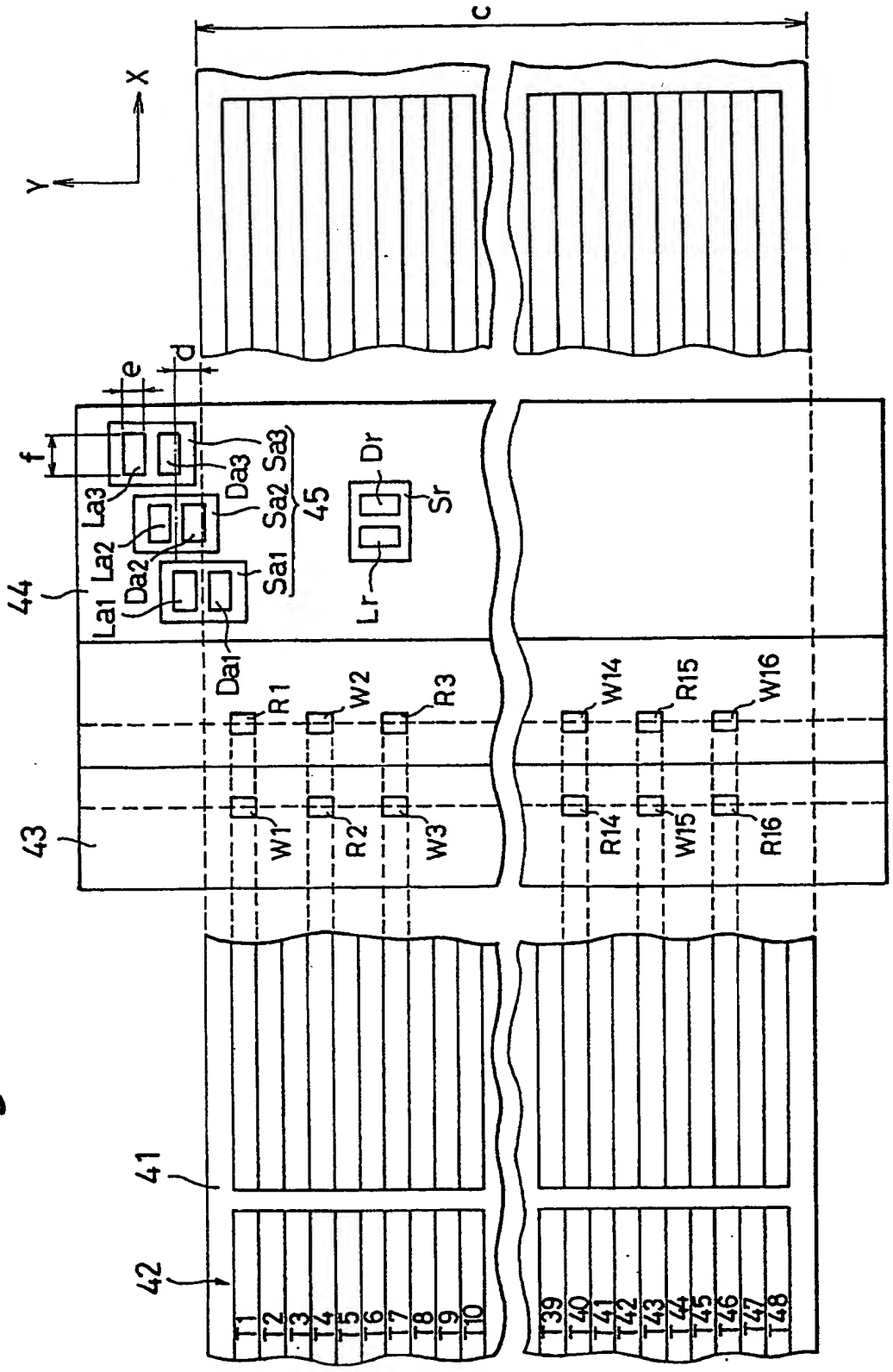

53
VOICE COIL TYPE LINEAR MOTOR
52
MOTOR DRIVER
48 HEAD DRIVER MEANS
51
SERVO CONTROLLER
50
COMPARATOR
49
REFERENCE VOLTAGE GENERATOR
47 HEAD DRIVER CONTROL MEANS
REFLECTING TYPE PHOTOINTERRUPTER

Fig. 13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f
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La2
La3
Da1
Da2
Da3
Sa1
Sa2
Sa3
Lr
Dr
Sr
44
45
43
41
42
R1
W1
W2
R2
R3
W3
R14
W14
R15
W15
R16
W16
T1
T2
T3
T4
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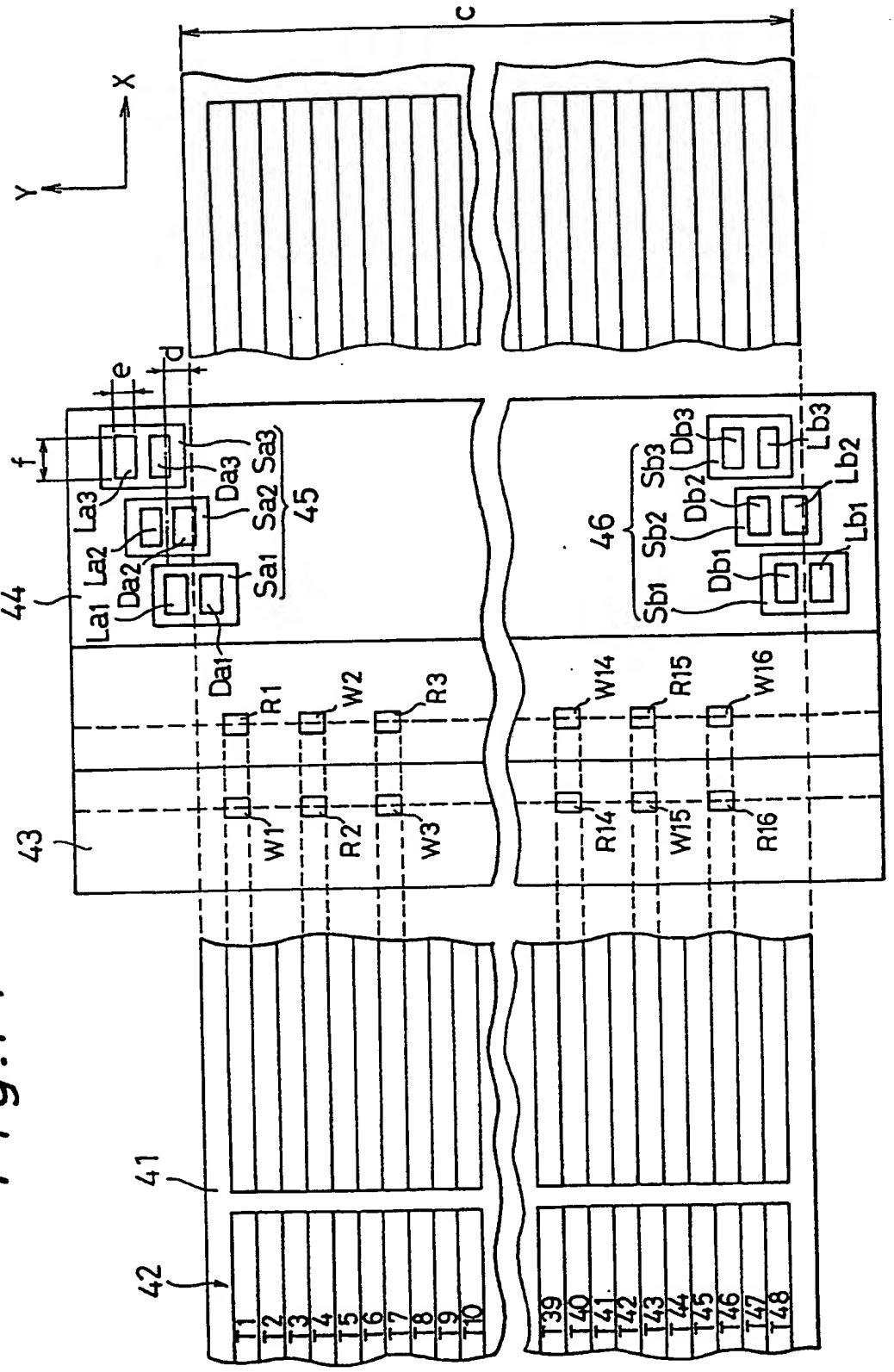
T47
T48

Fig.14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Sa3
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Sa1
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Sb3
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Sb1
Db3
Db2
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Lb3
Lb2
Lb1
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R1
W2
R3
W1
R2
W3
W14
R15
W16
R14
W15
R16
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42
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T48

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European Patent Office
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20.02.90 JP 40190/90
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(54) Tracking control device for magnetic recording/reproducing apparatus.

(57) A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is successively moved in the widthwise direction of a magnetic tape for switching tracking positions so that data recording/reproducing is, by each of the plurality of magnetic heads, performed along a plurality of data tracks formed on the magnetic tape in parallel to a direction in which the magnetic tape moves. The tracking control device has at least two servo signal reproducing heads provided integrally with the head unit and provided for the purpose of reproducing servo signals for tracking use from a plurality of servo tracks formed in parallel to the data tracks on the magnetic tape, and movement control unit for controlling, at each of the tracking positions, movement of the head unit in the widthwise direction in accordance with the difference in two servo signals reproduced by adjacent two of the servo signal reproducing heads corresponded to each of the tracking positions.

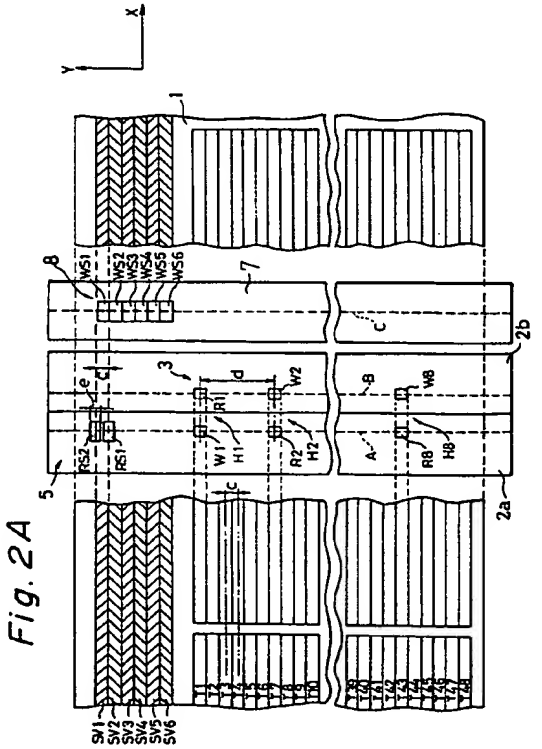

Fig. 2A

EP 0 443 810 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number EP 91301302.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP - A - 0 069 548 (IRWIN INTERNATIONAL INC.) * Fig. 3,5; abstract * --	1,5,7, 9,11, 14,16, 17	G 11 B 5/55 G 11 B 5/58 G 11 B 5/584
A	EP - A - 0 032 660 (OLYMPUS OPTICAL CO. LTD.) * Fig. 1,2,5-7; abstract * --	1,5,7, 9,11, 14,16, 17	
A	EP - A - 0 062 279 (TANDBERG DATA A/S) * Fig. 1-3; abstract * ----	1,5,7, 9,11, 14,16, 17	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G 11 B 5/00
G 11 B 21/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	25-06-1992	BERGER

CATEGORY OF CITED DOCUMENTS

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(54) **Tracking control device for magnetic recording/reproducing apparatus.**

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Description

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention relates to a tracking control device for a magnetic recording/reproducing apparatus for recording/reproducing information along a plurality of tracks running in parallel to the direction in which a magnetic tape moves by successively moving magnetic heads in the widthwise direction of the magnetic tape.

(2) Description of the Related Art

Hitherto, a magnetic recording/reproducing device for use in an audio apparatus has been usually arranged in such a manner that the number of the tracks and that of the heads are the same except for devices having a rotary head. The "number of the tracks" means the total number of data tracks formed in parallel to a direction in which the tape moves. The "number of heads" means the number of magnetic heads included by a combination head which integrally has magnetic heads such as the recording heads and reproducing heads or the recording/reproducing heads. A magnetic recording/reproducing apparatus of the type described above is provided with tape head relative position restricting means for restricting the relative position between the magnetic tape and the magnetic head. A typical restricting means has a guide post in which there is formed a pair of flanges for guiding the two widthwise directional ends of the magnetic tape.

Since the above-described tape head relative position restricting means is arranged to prevent the vertical waving of the magnetic tape by bringing the two ends of the magnetic tape into contact with the flanges, there arises a fear, when a magnetic tape the width of which is larger than the distance between the two flanges is moved, in that the two ends of the magnetic tape can be damaged due to mechanical stress applied to the two ends of the magnetic tape. Since the magnetic tape must be protected from damage, it has been difficult to improve the accuracy in positioning the magnetic tape up to several tens of micromillimeters. What is even worse, the above-described problem experienced with a high density magnetic recording/reproducing apparatus the allowable offtrack quantity of which is in a range between a level of ten and several tens of millimeters cannot satisfactorily be overcome by simply restricting the positional movement of the magnetic tape by the above-described flanges.

Recently, thin film magnetic heads have been advanced, causing combination heads of a type having a large number of heads to be developed. Therefore, the degree of density in the multi-track magnetic recording/reproducing apparatus can further be raised. The apparatus of the type described above is able to record data to a track having a narrower width. However, also the allowable offtrack is reduced. Therefore, an apparatus of the type described above have a tape head relative position restricting means arranged to comprise, in addition to the above-described flanges, control means for causing the magnetic head to follow waving of the magnetic tape by its means for detecting the relative position between the magnetic head and the magnetic tape or between the magnetic head and a track and head drive means for moving the magnetic head in the widthwise direction of the tape.

The above-described apparatus is exemplified by a fixed head digital audio tape recorder arranged in such a manner that the number of the heads and that of the tracks are the same.

The above-described apparatus is, as disclosed in Singaku Giho EA83-56, Shingaku Giho EA81-64 and Sharp Giho 1984-28, arranged in such a manner that a servo only track recorded on a magnetic tape is traced by a pair of reproducing heads disposed in parallel to each other in the widthwise direction of the tape. The thus obtained reproduced outputs are subjected to a comparison so that a following control is performed. As a result, the relative position between the magnetic head and the magnetic tape is restricted.

As another example of the tape head relative position restricting means, a control device of a magnetic recording/reproducing apparatus which is arranged in such a manner that the number of the heads and that of the tracks are the same has been disclosed (Japanese Patent Publication No. 63-64811). The control device is arranged in such a manner that a tracking signal is recorded along an end of the magnetic tape in the widthwise direction. The tracking signal thus recorded is reproduced by a servo reproducing head so as to subject the reproduced signal level to a comparison with a reference level. As an alternative to this, tracking information is recorded along the two ends of the magnetic tape in the widthwise direction. The thus recorded tracking information is reproduced by a pair of servo reproducing heads. The levels of the two reproduced signals are subjected to a comparison with each other. As a result, the tracking is performed.

Since the multi-track magnetic recording/reproducing apparatus such as the above-described fixed head digital audio tape recorder is arranged in such a manner that the track pitch is about hundreds of micromilli-

meters, a combination head in which a plurality of recording heads and reproducing heads are integrally formed can be used by employing a thin film head, the plurality of recording heads and the reproducing heads corresponding to a plurality of tracks formed on the magnetic tape.

GB 2 008 290 discloses a tracking control device in which light sources on one side of the tape project light past either edge of the tape to respective light detectors on the other side of the tape mounted to a holder supporting a magnetic multichannel head. The holder is moved in the widthwise direction of the tape in accordance with the difference between signals from the light detectors to maintain tracking. The holder may be subjected to a displacement and the direction of movement may be reversed.

EP 032 660 discloses a tracking control device for maintaining a magnetic head in alignment with the tape having servo tracks provided towards either edge. Servo signal reproducing heads are provided at either end of the magnetic head, angled away from the magnetic head. The magnetic head is positioned in the widthwise direction of the tape in accordance with the phase difference between the reproduced servo signals from the servo signal reproducing heads.

In order to further raise the recording density, the track width can be reduced by reducing the gap width of the magnetic head. However, since the degree of integration of the thin film head involves a certain limitation, the track pitch cannot be reduced satisfactorily. What is even worse, when the number of the heads is increased, the size of the circuit will be enlarged, causing an excessive cost to be raised. Therefore, a high density magnetic recording/reproducing apparatus which is arranged in such a manner that the track pitch is several tens of micromillimeters and the number of the tracks is several tens to hundreds cannot be realised by a structure in which the number of the heads and the number of the tracks are the same.

Accordingly, a recording system called a serpentine system has recently been employed in a multi-track magnetic recording/reproducing apparatus which is a back up storage device for an information processing system and which is usually called a cassette streamer, the serpentine system being arranged in such a manner that the number of the heads is smaller than the number of the recording tracks.

The serpentine system will be described with reference to Fig. 1. A magnetic tape 21 which moves in direction X and the width of which is designated by Y has a track group 22 composed of 16 tracks T_1 to T_{16} which are, for example, formed in direction Y at equal pitch a. A combination head 23 is disposed to correspond to the above-described track group 22, the combination head 23 comprising, for example, four recording heads W_1 to W_4 and four reproducing heads R_1 to R_4.

The recording heads W_1 to W_4 are disposed in the direction Y at same pitch b (b = 4a), each of the reproducing heads R_1 to R_4 being arranged to form a pair in cooperation with corresponding recording heads W_1 to W_4 disposed in direction X or - X.

When the recording or reproducing operation is performed, the above-described combination head 23 is first moved to a position shown in Fig. 1. That is, it is moved to a position at which the center of the recording head W_1 and that of the reproducing head R_1 coincide with the center of the track T_1, the center of the recording head W_2 and that of the reproducing head R_2 coincide with the center of the track T_5, the center of the recording head W_3 and that of the reproducing head R_3 coincide with the center of the track T_9 and the center of the recording head W_4 and that of the reproducing head R_4 coincide with the center of the track T_{13}.

In this state, the magnetic tape 21 is moved in the direction X when data is recorded so that data is simultaneously recorded to the tracks T_1 and T_9 by the recording heads W_1 and W_3.

After data recording to a lengthwise end of the magnetic tape 21 has been ended, the magnetic tape 21 is moved in the direction - X so that data is simultaneously recorded to the tracks T_5 and T_{13} by the recording heads W_2 and W_4. After data recording to a lengthwise end of the magnetic tape 21 has been ended, the combination head 23 is moved in the direction - Y by the track pitch a so that the center of the recording head W_1 and that of the reproducing head R_1 are made coincide with the center of the track T_2. Then, the magnetic tape is allowed to reciprocate in the directions X and - X while maintaining the thus realized relative position. As a result, data is recorded to the tracks T_2, T_6, T_{10} and T_{14}. Then, the combination head 23 is similarly moved by a in the direction - Y whenever the magnetic tape 21 reciprocates once. Thus, information is recorded to all of tracks T_1 to T_{16} after four times of the reciprocating motions have been completed.

Since the above-described serpentine system multi-track magnetic recording/reproducing apparatus is constituted in such a manner that data is recorded/reproduced from a multiplicity of tracks by moving a reduced number of magnetic heads in the widthwise direction of the tape. Therefore, the track pitch can be reduced and the number of the tracks can thereby be increased by arranging the structure in which the magnetic head is moved by a multiplicity of times. Therefore, the thin film head can be integrated smoothly.

As the head tape relative position restricting means of the serpentine system multi-track magnetic recording/reproducing apparatus, a head positioning technology has, as disclosed in, for example, Japanese Patent Laid-Open No. 62-183019, been known in which the stepping motor is open-loop-controlled in addition to the restriction performed by the above-described flanges.

However, in the serpentine system magnetic recording/reproducing apparatus in which the track pitch is several tens of micromillimeters, the track width becomes, of course, several tens of micromillimeters. Therefore, the offtrack becomes several micromillimeters. However, the tape head relative position restricting means arranged in such a manner that the above-described described open-loop control is performed cannot correspond to the small above-described allowable offtrack.

In a case where the total stroke of the combination head of the above-described serpentine system magnetic recording/reproducing apparatus is about lmm at the time of switching the track, the servo reproducing head must have a relatively large dynamic range of about 60 dB in order to reduce the tracking residual error to be smaller than 1 μm.

However, the conventional method in which one servo track is traced by two servo heads encounters a problem in that satisfactory S/N ratio and linearity cannot be obtained in overall region of the large dynamic range. Therefore, the tracking accuracy at each track switch position has been unsatisfactory.

In the applicant's prior application EP 0 390 555 to be considered under Art.54(3) there are disclosed a number of tracking control devices in which light from a light source is interrupted by an edge of a tape to cast a pattern of light on one or more detector. The pattern of light cast on the one or more detector is used to position the magnetic head at one of a plurality of tracking positions. The tracking control device of one aspect of the present invention utilises reflecting type photointerrupters in which the light source and light sensor are integrated into a simple assembly.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a tracking control device for a serpentine system magnetic recording/reproducing apparatus capable of overcoming the problems of the above-described conventional apparatuses.

The object of the invention can be achieved by each of the following devices.

A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is movable in the widthwise direction of a magnetic tape to maintain tracking so that data recording/reproducing may be performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising:

at least two servo signal reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use from a plurality of servo tracks formed in parallel to said data tracks on said magnetic tape, and

movement control means for controlling movement of said head unit in said widthwise direction in accordance with the difference between two servo signals reproduced by two of said servo signal reproducing heads,

characterised in that said head unit is moveable between a plurality n of tracking positions so that for each magnetic head data recording/reproducing may be performed along a plurality of said data tracks, wherein at each tracking position said movement control means moves said head unit according to the difference between two servo signals reproduced by two adjacent servo signal reproducing heads and wherein a pitch of said servo tracks is an integer multiple $K \geqq 1$ of the pitch of said data tracks, the number of said servo tracks is in the case of two servo heads and $K = 1$ the same and in the case of more than two servo heads and $K > 1$ smaller than the number n of said tracking positions and said servo signal reproducing heads are disposed at substantially the same pitch as said pitch of said data tracks in said widthwise direction (Fig. 2A - 4B).

A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is moveable in the widthwise direction of a magnetic tape to maintain tracking so that data recording/reproducing may be performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising:

servo signal reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use, and

movement control means for controlling movement of said head unit in said widthwise direction in accordance with the difference in two servo signals reproduced by two of said servo signal reproducing heads, characterised in that

said head unit is movable between a plurality of tracking positions so that for each magnetic head data recording/reproducing may be performed along a plurality of said data tracks, wherein at each track position said movement control means moves said head unit according to the difference between two servo signals reproduced by two adjacent servo signal reproducing heads from a servo track formed in parallel to said data

tracks on said magnetic tape, and wherein th number of said s rvo signal reproducing heads is larg r than, by on , the number of said tracking positions and said serv signal reproducing h ads are, in said widthwis direction, disposed at substantially the sam pitch as the pitch of said data tracks (Fig. 5A - 6).

A tracking control devic for a magn tic r cording/reproducing apparatus arranged in such a mann r that a head unit having a plurality of magnetic heads is moveable in the widthwise direction of a magnetic tape to maintain tracking so that data recording/reproducing may be performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising:

servo signal reproducing heads provided integrally with said head unit and provided for the purpose of reproducing servo signals for tracking use recorded along said magnetic tape; and

movement control means for controlling movement of said head unit in said widthwise direction of said tape, characterised in that

said head unit is moveable between a plurality of tracking positions so that for each magnetic head data recording/reproducing may be performed along a plurality of said data tracks wherein at each tracking position said movement control means moves said head unit in accordance with the difference between the level of the servo signal reproduced from a servo track along one edge of said tape by one of said servo signal reproducing heads corresponding to that tracking position and a level of a predetermined reference signal, and wherein the number of said servo signal reproducing heads is the same as the number of said tracking positions and said servo signal reproducing heads are, in said widthwise direction, disposed at substantially the same pitch as the pitch of said data tracks (7A - 7C and 9).

A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit having a plurality of magnetic heads is moveable in a widthwise direction of a magnetic tape to maintain tracking positions so that data recording/reproducing may be performed along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which said magnetic tape moves, said tracking control device comprising:

a plurality of servo signal reproducing heads provided integrally with said head unit for tracking use; and

movement control means for controlling movement of said head unit in said widthwise direction in accordance with the difference between servo signals reproduced by two of said servo signal reproducing heads characterised in that

said plurality of servo signal reproducing heads comprise:

a first group of servo-signal reproducing heads for reproducing servo signals for tracking use recorded along one edge of said magnetic tape; and

a second group of servo-signal reproducing heads for reproducing servo signals for tracking use recorded along the other edge of said magnetic tape;

and in that said head unit is moveable between a plurality of tracking positions so that for each magnetic head data recording/reproducing may be performed along a plurality of said data tracks, wherein at each tracking position said movement control means moves said head unit in accordance with the difference between the level of a servo signal reproduced by one servo signal reproducing head of said first group corresponding to that track position and the level of a servo signal reproduced by a servo signal reproducing head of the second group corresponding to that track position, and wherein the number of said servo-signal reproducing heads of said first group and that of said second group are the same as the number of said tracking positions and wherein servo-signal reproducing heads of said first group and said second group are, in the widthwise direction, disposed at substantially the same pitch as the pitch of said data tracks (Fig. 8A - 8B and 10).

A tracking control device for a magnetic recording/reproducing apparatus having a combination head including a plurality of magnetic heads being arranged to perform data recording/reproducing along a plurality of data tracks formed on a magnetic tape in parallel to a direction in which the magnetic tape moves, said tracking control device comprising:

a plurality of photointerrupters for generating tracking control signals; and

movement control means for controlling movement of said combination head in said widthwise direction in accordance with signals from said photointerrupters,

characterised in that said head unit is moveable between a plurality of tracking positions so that for each magnetic head data recording/reproducing may be performed along a plurality of said data tracks and in that each ph tointerrupter is a reflecting typ photointerrupter for gen rating a signal indicating the int nsity of light reflected from said magnetic tape provided integrally with said combination head so as to oppos an edg of said magn tic tap at a respective tracking p siti n, and in that said movem nt control m ans controls the movement f said c mbination h ad at each tracking positi n in accordance with th differenc between th level of a signal generated by a reflecting type ph toint rrupter and the l v l of a pre-det rmin d reference

signal, and in that the number of magnetic heads is smaller than the number of data tracks and the number of said reflecting type photointerrupters is the same as the number of said tracking positions and said reflecting type photointerrupters are disposed at substantially the same pitch as the pitch of said data tracks (Fig. 11 - 13).

A tracking control device for a magnetic recording/reproducing apparatus having a combination head including magnetic heads arranged to perform data recording/reproducing along a plurality of data tracks formed on said magnetic tape in parallel to a direction in which the magnetic tape moves, said tracking control device comprising:

a plurality of photointerrupters provided adjacent the edges of said magnetic tape for generating tracking control signals; and

movement control means for controlling the movement of said combination head in a widthwise direction in accordance with the difference between the level of a signal generated by one of said photointerrupters adjacent one edge and the level of a signal generated by one of said photointerrupters adjacent the other edge of said tape,

characterised in that said combination head is moveable between a plurality of tracking positions so that for each magnetic head data recording/reproducing may be performed along a plurality of said data tracks and in that the photointerrupters comprise first and second groups of reflecting type photointerrupters formed integrally with said combination head for generating a signal indicating the intensity of light reflected from said magnetic tape, and wherein each photointerrupter of the first group is positioned so as to oppose one edge of said magnetic tape at a different one of said tracking positions and each photointerrupter of the second group is positioned so as to oppose the other edge of said magnetic tape at a different one of said tracking positions, and wherein said movement control means controls the movement of said combination head in a widthwise direction at each track position in accordance with the difference between a level of a signal generated by a photointerrupter of the first group opposite one edge of the tape and the level of a signal generated by a photointerrupter of the second group opposite the other edge of the tape, and wherein the number of said reflecting type photointerrupters of said first group and that of said second group are the same as the number of said tracking positions and said reflecting type photointerrupters of said first group and said second group are, in said widthwise direction, disposed at substantially the same pitch as the pitch of said data tracks (Fig 14).

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a tracking control device of a conventional serpentine system magnetic recording/reproducing apparatus;

Figs. 2A and 2B illustrate a first embodiment of a tracking control apparatus according to the present invention;

Fig. 3 is a block diagram which illustrates drive means of a tracking control device according to the first embodiment;

Figs. 4A and 4B illustrate a modification to the first embodiment of the tracking control device;

Figs. 5A and 5C illustrate a second embodiment of the tracking control device according to the present invention;

Fig. 5B is a block diagram of a drive means of the tracking control device according to the second embodiment;

Fig. 6 illustrates a modification to the second embodiment of the tracking control device;

Figs. 7A and 7C illustrate a third embodiment of the tracking control device according to the present invention;

Fig. 7B is a block diagram of a drive means of the tracking control device according to the third embodiment;

Fig. 8A illustrates a first modification to the third embodiment of the tracking control device;

Fig. 8B is a block diagram of a drive means of the tracking control device according to a first modification;

Fig. 9 illustrates a second modification to a third embodiment of the tracking control device;

Fig. 10 illustrates a third modification to the third embodiment of the tracking control device;

Fig. 11 illustrates a fourth embodiment of the tracking control device according to the present invention;

Fig. 12 is a block diagram of a drive means of the tracking control device according to the fourth embodiment;

Fig. 13 illustrates a first modification to the fourth embodiment of the tracking control device; and

Fig. 14 illustrates a second modification to the fourth embodiment of the tracking control device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first embodiment of the present invention will now be described with reference to Figs. 2A, 2B and 3.

A magnetic recording/reproducing apparatus according to the first embodiment is used to serve as a back-up storage device for, for example, a hard disk apparatus. The above-described apparatus employs a serpentine method which enables information to be recorded/reproduced from each of tracks by successively moving magnetic heads of the number which is smaller than the number of the tracks of the magnetic tape in the widthwise direction of the magnetic tape.

As shown in Fig. 2A, the magnetic recording/reproducing apparatus comprises, as a head unit, a combination head 3 having recording heads W1 to W8 and reproducing heads R1 to R8 (partially illustrated) which are formed as thin film heads on a pair of substrates 2a and 2b extending in direction Y which is the widthwise direction of a magnetic tape 1, the substrates 2a and 2b being adhered to each other. The combination head 3 can be moved in the direction Y or - Y by a drive means such as a voice coil type linear motor 17 (see Fig. 3).

As a magnetic tape 1, for example, a quarter-inch-wide tape is used. The magnetic tape 1 has 48 data tracks T1 to T48 extending in the direction Y and in parallel to the direction in which the magnetic tape 1 moves (in direction X), the magnetic tape 1 being formed at a predetermined track pitch c (for example, 120 μm). As a result, information can be recorded/reproduced along the 48 data tracks T1 to T48.

The substrate 2a is arranged to have odd recording heads W1, W3, W5 and W7 and even reproducing heads R2, R4, R6 and R8 which are respectively arranged alternately. The gaps of the heads formed on the substrate 2a are positioned on a straight line designated by a dashed line A.

The substrate 2b is arranged to have odd reproducing heads R1, R3, R5 and R7 and even recording heads W2, W4, W6 and W8 which are respectively arranged alternately. The gaps of the heads formed on the substrate 2b are positioned on a straight line designated by a dashed line B.

The above-described recording heads W1 to W8 and the reproducing heads R1 to R8 are respectively arranged in the direction X which is the direction in which the magnetic tape 1 moves so that magnetic head pairs H1 to H8 are formed. The X directional positions of the recording head and the reproducing head are alternated when viewed in the adjacent two magnetic head pairs. The Y directional length of the recording heads W1 to W8 and the reproducing heads R1 to R8 are the same referring to the drawing. However, the actual apparatus is arranged in such a manner that the width of a region to which information can be recorded by each of the recording heads W1 to W8 is arranged to be slightly larger than the width of a region from which information can be reproduced by each of the reproducing heads R1 to R8.

The Y directional interval d between the adjacent magnetic head pairs is arranged to be 6c (for example, 720 μm). The drive means comprising the voice coil type linear motor 17 moves, six times, the combination head 3 in the direction Y at each track pitch, that is, performs the 6 times of the track switching operation, so that information can be recorded/reproduced from all of the data tracks T1 to T48.

A substrate 7 is positioned from a predetermined X directional distance from the substrate 2b. The substrate 7 has, at an end thereof, a servo recording portion 8 comprising six, which is the same number as that of the track switching operations, servo signal recording heads WS1 to WS6 in the direction Y. The Y directional length of each of the servo signal recording heads WS1 to WS6 and the intervals between the adjacent servo signal recording heads are respectively arranged to be the same as the pitch c of the data tracks T1 to T48.

Each of the servo signal recording heads WS1 to WS6 is arranged to cause servo tracking signals having different frequencies to be recorded to 6 servo tracks SV1 to SV6 (designated by hatched sections) positioned in the vicinity of the Y directional end of the magnetic tape 1. The frequencies of the servo signals to be recorded to the servo tracks SV1 to SV6 are arranged in such a manner that the difference in the frequencies of the servo signals to be recorded to the two adjacent servo tracks is sufficiently large as shown in Table 1.

Table 1

Servo Track	Frequency
SV1	100 KHz
SV2	10 KHz
SV3	200 KHz
SV4	20 KHz
SV5	300 KHz
SV6	30 KHz

A servo reproducing portion 5 is provided in a Y directional end portion of the substrate 2a. The servo reproducing portion 5 has two servo signal reproducing heads RS1 and RS2 arranged in the direction Y at the same interval as that of the track pitch c. The Y directional length e of each of the servo signal reproducing heads RS1 and RS2 is arranged to be a value which is slightly smaller than the track pitch c, for example, the length e is arranged to be 100 μm.

The above-described servo signal reproducing heads RS1 and RS2 are positioned at a reference position shown in Fig. 2A, that is, at positions at which the magnetic head pair H1 confronts the data track T1 so as to cover the upper portion and the lower portion of the servo track SV1 positioned at a Y directional end portion by the same width. As a result, the levels of the signals, which are reproduced from the servo track SV1 by the servo signal reproducing heads RS1 and RS2, are made to be the same. The gap of the servo signal reproducing head RS1 and that of the servo signal reproducing head RS2 are positioned on a straight line designated by a dashed line A.

As shown in Fig. 3, the servo signal reproducing heads RS1 and RS2 are respectively connected to a comparator 14 via band pass filters (BPF) 10 and 11 and amplitude detectors 12 and 13. The BPFs 10 and 11 change their frequency characteristics for each of the servo tracks SV1 to SV6 so as to pass components having frequencies which approximate to the frequency of the servo signal among the servo signals, which have been recorded to the servo tracks SV1 to SV6, to be reproduced by the heads RS1 and RS2. Another structure may be employed in which the band pass filters 10 and 11 corresponding to the servo tracks SV1 to SV6 are selectively used.

The output from the comparator 14 is connected to a servo controller 15 the output from which is connected to the voice coil type linear motor 17 via a motor driver 16. The voice coil type linear motor 17 moves the servo reproducing portion 5 and the combination head 3 formed integrally with the servo reproducing portion 5 in the direction Y or - Y.

Although omitted from the illustration, a flange member for reducing the Y directional waving of the magnetic tape 1 to a degree about ± 20 μm by restricting the widthwise ends of the magnetic tape 1.

Information is recorded to the magnetic tape 1 in such a manner that the magnetic tape 1 is moved in the direction X so as to record information by odd recording heads W1, W3, W5 and W7 to the data tracks T1, T13, T25 and T37 while recording servo signals by the servo signal recording heads WS1 to WS6 to the servo tracks SV1 to SV6 at frequencies shown in Table 1 or the same has been recorded. At this time, recorded information is immediately reproduced by the odd reproducing heads R1, R3, R5 and R7 to validate its contents. If there is an error, information is again recorded.

At this time, the servo signal is reproduced from the Y directional end servo track SV1 by two servo signal reproducing heads RS1 and RS2. The comparator 14 compares the amplitude of the signals reproduced by the servo signal reproducing heads RS1 and RS2 via band pass filters 10 and 11 which pass only th compon nts in the vicinity of 100 KHz which is th frequency f th serv signal f th s rvo track SV1 and the amplitude d t ctors 12 and 13. The s rvo controll r 15 rotates th voice type linear motor 17 via th motor driver 16 in accordance with th utput from the comparator 14 so that th amplitud f th signal reproduced by the servo signal reproducing head RS1 and that reproduced by the servo signal reproducing head RS2 are

made to be same. As a result, the combination h ad 3 is moved in th direction Y or - Y. Therefore, the odd number r cording h ads W1, W3, W5 and W7 follow the corr sponding data tracks T1, T3, T25 and T37.

After information has be n r cord d to the X dir ctional end along th data tracks T1, T13, T25 and T37, th magnetic tap is moved in th - X direction, information is recorded to data tracks T7, T19, T31 and T43 by even number recording heads W2, W4, W6 and W8. At this time, recorded information is immediately reproduced by the even reproducing heads R2, R4, R6 and R8 to validate its contents. Also at this time, the servo signal is reproduced from the servo track SV1 by the servo signal reproducing heads RS1 and RS2 so that the tracking control is similarly performed. Since the servo signals have been recorded to the servo tracks SV1 to SV6 in the forward movement of the magnetic tape 1, it is not necessary.

When the information recording operation reaches the - X directional end, the combination head 3 is moved in the - Y direction by the track pitch c as shown in Fig. 2B. As a result, information is recorded to the data tracks T2, T14, T26 and T38 by the odd recording heads W1, W3, W5 and W7 while moving the magnetic tape 1 in the direction X. At this time, the servo signal is reproduced from the servo track SV2 by the servo signal reproducing heads RS1 and RS2. In order to make the signals reproduced by the servo signal reproducing heads RS1 and RS2, tracking is performed by moving the combination head 3 in the direction Y or - Y by the voice coil type linear motor 17. At this time, the frequency characteristics of the band pass filters 10 and 11 are changed to the characteristics which allows only the components to pass, the components having the frequencies which are near 10 KHz which is the frequency of the servo signal of the servo track SV2. As an alternative to this, the BPFs 10 and 11 provided exclusively for the servo track SV2 may be selected.

When the information recording operation reaches the X directional end, the magnetic tape 1 is moved in the direction - X. As a result, information is recorded to the data tracks T8, T20, T32 and T44 by the even recording heads W2, W4, W6 and W8 while performing tracking in accordance with the outputs from the servo signal reproducing heads RS1 and RS2. Also at this time, the tracking is performed by the servo track SV2.

Then, the track is switched six times by combining, as shown in Table 2, the recording heads W1 to W8 and the data tracks T1 to T48 while similarly moving the combination head 3 in the direction - Y by the distance corresponding to the track pitch c whenever the magnetic tape 1 reciprocates and changing the subject servo track to the adjacent track when viewed in the direction - Y. As a result, information is recorded to all of the data tracks T1 to T48.

Table 2

	Forward Passage	Reverse Passage
Track Switch I (SV1 is used)	W1-T1, W3-T13 W5-T25, W7-T37	W2-T7, W4-T19 W6-T31, W8-T43
Track Switch II (SV2 is used)	W1-T2, W3-T14 W5-T26, W7-T38	W2-T8, W4-T20 W6-T32, W8-T44
Track Switch III (SV3 is used)	W1-T3, W3-T15 W5-T27, W7-T39	W2-T9, W4-T21 W6-T33, W8-T45
Track Switch IV (SV4 is used)	W1-T4, W3-T16 W5-T28, W7-T40	W2-T10, W4-T22 W6-T34, W8-T46
Track Switch V (SV5 is used)	W1-T5, W3-T17 W5-T29, W7-T41	W2-T11, W4-T23 W6-T35, W8-T47
Track Switch VI (SV6 is used)	W1-T6, W3-T18 W5-T30, W7-T42	W2-T12, W4-T24 W6-T36, W8-T48

The reproduction mode is arranged similarly to the recording mode in such a manner that the combination head 3 is moved in the direction - Y by a distance corresponding to the track pitch c whenever the magnetic tape 1 reciprocates once. Furthermore, information is reproduced from data tracks T1 to T48 while changing the subject servo track by the servo track positioned adjacently when viewed in the direction - Y.

Although the apparatus according to the first embodiment has the servo signal recording heads WS1 to WS6, the servo signal recording heads WS1 to WS6 can be omitted from the illustration by arranging the structure in such a manner that the servo signals are previously recorded to the servo tracks SV1 to SV6 when the magnetic tape 1 is manufactured.

According to the first embodiment, the number of the track changing operations is arranged to be 6, the present invention is not limited to 6. In this case, the number of the servo tracks must be changed to correspond to the number of the track changing operations.

Then, a modification to the first embodiment will be described with reference to Figs. 4A and 4B.

According to this modification, the number of the track switching operations is arranged to be 6 similarly to the first embodiment. Furthermore, three servo signal recording heads WS1 to WS3 are provided in the servo recording portion 8 at a pitch (for example, a pitch of 240 μm) which is two times the track pitch of the data tracks T1 to T48. On the other hand, three servo signal reproducing heads RS1 to RS3 for reproducing information from the servo tracks SV1 to SV3 are provided in the servo reproducing portion 5 at a pitch (for example, 120 μm) which is the same pitch as the track pitch c. As a result, when the magnetic head pair H1 confronts the data track T1, the two servo signal reproducing heads RS1 and RS2 respectively cover the upper portion of the servo track SV1 and the lower portion of the same. The same elements as those according to the first embodiment are given the same reference numerals and descriptions are omitted here.

Since information is, according to the thus arranged structured modification, record d similarly to th first embodiment, nly th procedure of the tracking p ration will be d scrib d.

In th first reciprocation p rati n of the magnetic tap , that is, at the track switch positi n at which th rec rding h ad W1 and th reproducing head R1 confront the data track T1, th serv reproducing heads RS1 and RS2 reproduces servo signals from the servo track SV1. Th two reproduced signals are subjected to a

comparison so that the tracking is performed.

Table 3

Track Switch Position	Subject Servo Track	Servo signal Reproducing Head
I	SV1	RS1, RS2
II	SV1	RS2, RS3
III	SV2	RS1, RS2
IV	SV2	RS2, RS3
V	SV3	RS1, RS2
VI	SV3	RS2, RS3

In the second reciprocation operation, that is, at the track switch position at which the recording head W1 and the reproducing head R1 confront the data track T2, servo signal SV1 is, as shown in Fig. 4B, reproduced from the servo track SV1 by the servo signal reproducing head RS2 and RS3. The reproduced servo signal SV1 is subjected to a comparison so that tracking is performed.

Then, the third and the ensuing reciprocation operation is similarly performed in such a manner that the servo track and the servo signal reproducing head are successively switched in accordance with Table 3 so that tracking at each track switch positions is performed.

A second embodiment of the present invention will be described with reference to Figs. 5A, 5B and 5C. The same elements, which are the same as those according to the first embodiment, are given the same reference elements and their descriptions are omitted from here. As shown in Fig. 5A, a servo signal recording head WS is provided in the vicinity of the widthwise end portion of the magnetic tape 1 so as to record the servo signal to the servo track 20 (designated by hatching for convenience) formed in parallel to the data tracks T1 to T48. The gap of the servo signal recording head WS is positioned on dashed line C. The servo reproducing portion 5 has 7 servo reproducing heads RS1 to RS7 respectively arranged at same intervals which are the same as the track pitch c and in the direction Y. The number of the servo signal reproducing heads 7 is arranged to be the number which is larger than the number of the track switching operations by one. According to this embodiment, since the number of the track switching operations is arranged to be 6, seven servo reproducing heads RS1 to RS7 are provided. The servo signal reproducing heads RS1 to RS7 are positioned in such a manner that the heads RS1 and RS2 respectively cover the lower portion and the upper portion of the servo track 20 by the same widths in order to make the levels of the signals reproduced from the servo track 8 by the heads RS1 and RS2 when the recording head W1 and the reproducing head R1 confront the data track T1.

As shown in Fig. 5B, any of the outputs from the servo signal reproducing head pairs RS1/RS2, RS2/RS3,... for use at each of the track switch position is received by amplitude detectors 21 and 22. The outputs from the amplitude detectors 21 and 22 are received by a comparator 23, the output from the comparator 23 being received by a servo controller 24. The servo controller 24 acts to rotate a voice coil type linear motor 26 via a motor driver 25.

Fig. 5A illustrates a status where information is recorded or reproduced from tracks T1, T7, T13, T19, T25, T31, T37 and T43 by using heads RS1 and RS2. Fig. 5C illustrates a status where information is recorded or reproduced from tracks T2, T8, T14, T20, T26, T32, T38 and T44 by using heads RS2 and RS3. Since the recording and the reproducing operations are substantially the same as those according to the first embodiment, their descriptions are omitted here.

According to the second embodiment, the servo signal recording head WS for recording the servo signal is provided in the servo track 20, the servo signal recording head WS can be omitted from illustration in a case wh re th structure is arranged in such a manner that the s rvo signal is previously recorded to the servo track 20 at the tim f manufacturing the magnetic tape 1.

According to th second mb diment, th number of the track switching operati ns is arrang d t be 6, it can pti nally b arranged. In this case, the number f the servo signal r producing heads must be arranged to be the numb r which is larger than the track switching operation by on .

Th second embodim nt is arranged in such a manner that th servo signal r producing heads RS1 to RS7 are provid d on th substrat 2a on which th recording and reproducing heads ar provid d. Howev r, another structur may be mploy d which is arranged in such a manner that th servo signal r producing heads RS1 to RS7 are provided on th substrate 2b or on anoth r substrat xcept for th substrat s 2a and 2b so as to be adhered to the substrates 2a and 2b.

Then, a modification to the second embodiment will be described with reference to Fig. 6.

According to this embodiment, odd servo signal reproducing heads RS1, RS3, RS5 and RS7 are disposed on the substrate 2a, while even servo signal reproducing heads RS2, RS4, RS6 are disposed on the substrate 2b. Furthermore, the gap of each of odd servo reproducing heads RS1, RS3, RS5 and RS7 is positioned on dashed line A, while the gap of each of even servo reproducing heads RS2, RS4 and RS6 is positioned on dashed line B. As a result, the degree of integration of the servo reproducing heads RS1 to RS7 can be moderated. Therefore, the servo reproducing heads RS1 to RS7 in the form of the thin film head can easily be manufactured.

A third embodiment of the present invention will be described with reference to Figs. 7A, 7B and 7C.

According to this embodiment, the same elements which are the same as those according to the first and the second embodiments are given the same reference numerals and their descriptions are omitted here.

According to the third embodiment, the servo signal recording head WS for recording the servo signal along a widthwise directional end portion 30 of the magnetic tape 1 is provided at an end portion of the substrate 7.

The servo reproducing portion 5 has 6 servo signal reproducing heads RS1 to RS6 arranged in the direction Y at intervals each of which is the same as the track pitch c. The number of the servo signal reproducing heads RS1 to RS6 is arranged to the same as the number of the track switching operation. Since the number of the track switching operation is arranged to be 6 according to this embodiment, 6 servo reproducing heads RS1 to RS6 are provided. The gaps of the servo signal reproducing heads RS1 to RS6 are positioned on a straight line designated by dashed line A.

A control means is, as shown in Fig. 7B, arranged in such a manner that a drive means 34 moves the combination head 3 in the direction Y in accordance with the outputs from the corresponding servo reproducing heads RS1 to RS6 so as to guide the magnetic head pairs H1 to H8 to the central portion of the corresponding tracks.

The control means comprises an amplitude detector 31 for detecting the amplitude of the output from any of the head among the servo signal reproducing heads RS1 to RS6 which is being used. The control means further comprises a reference amplitude voltage generator 32 for generating reference amplitude voltage and a comparator 33 for generating an error signal by comparing the output levels with each other. A drive means 34 moves the servo signal reproducing heads RS1 to RS6 and the combination head 3 in the direction Y or -Y in response to the error signal transmitted from the comparator 33. As a result, a desired track selected from the tracks T1 to T4 is followed. The drive means 34 may comprise, for example, a voice coil type linear motor.

Figs. 7A illustrates a state where information is recorded or reproduced from the tracks T1, T7, T13, T19, T25, T31, T37 and T43 by using the head RS1. Fig. 7C illustrates a state where information is recorded or reproduced from the tracks T2, T8, T14, T20, T26, T32, T38 and T44 by using the head RS2. Since the recording and reproducing operations are the same as those according to the first and the second embodiments, their description are omitted here.

According to the third embodiment, the servo signal recording head WS for recording the servo signal is provided in the servo track 20, the servo signal recording head WS can be omitted from illustration in a case where the structure is arranged in such a manner that the servo signal is previously recorded at the time of manufacturing the magnetic tape 1.

Fig. 8A illustrates a first modification of the third embodiment.

This modification is arranged in such a manner that servo signal recording heads WSa and WSb are respectively provided at the widthwise end portions of the substrate 7 so as to record the servo signals to two servo regions 30a and 30b at the widthwise end portions of the magnetic tape 1. A servo reproducing portion 5a is provided at either end portion, the servo signal reproducing portion 5a having 6 servo signal reproducing heads RS1a to RS6a which correspond to the track switching operation number 6. The 6 servo signal reproducing heads RS1a to RS6a are arranged in the widthwise direction of the magnetic tape 1 at same intervals each of which is the same as the track pitch c. On the other hand, a servo reproducing portion 5b is provided at the Y directional end portion of the magnetic tap 1, the servo signal reproducing portion 5b having 6 serv signal r producing heads RS1b to RS6b which correspond to th number of th track switching operations. The 6 s rvo signal r producing heads RS1b to RS6b ar arranged in the widthwis dir cti n f th magnetic tap 1 at same intervals each f which is th same as th track pitch c. Th serv signal r producing heads RS1a to RS6a correspond to RS1b to RS6b so that, wh n, for xample, RS1a is positi ned at either of th

widthwise directional ends of the magnetic tape 1, the corresponding head RS1b confront another end of the magnetic tape 1.

According to this modification, when information is recorded to the magnetic tape 1, the servo signals are recorded to servo regions 30a and 30b at the widthwise end portions of the magnetic tape 1 by the servo signal recording heads WSa and WSb while moving the magnetic tape 1 in the direction X. Simultaneously or after the servo signal has been recorded as described above, information is recorded to the tracks T1, T13, T25 and T37 by the odd recording heads W1, W3, W5 and W7. At this time, the amplitude of the servo signal reproduced by the servo signal reproducing head RS1a and the amplitude of the servo signal reproduced by the servo signal reproducing head RS1b are respectively detected by amplitude detectors 35 and 36 (see Fig. 8B) so as to be subjected to a comparison by the comparator 33. Then, the drive means 34 performs tracking so as to make the above-described two amplitudes to be the same. Then, the track switching operations are successively performed similarly to the first embodiment so that information is recorded to all of the tracks T1 to T48. In also the reproducing mode, the track switching operation is performed and the tracking is also performed similarly to the recording mode.

Since the first modification is arranged in such a manner that the outputs from the pair of the servo signal reproducing heads are subjected to the comparison, they can be compensated to each other. Therefore, an effect can be obtained in that the tracking can accurately be performed if the magnetic characteristics of the magnetic tape 1 are changed.

A second modification of the third embodiment will be described with reference to Fig. 9. This modification is arranged in such a manner that the odd servo signal reproducing heads RS1, RS3, RS5 are disposed on the substrate 2a, while even servo signal reproducing head RS2, RS4 and RS6 are disposed on the substrate 2b. As a result, the degree of integration of the servo signal reproducing heads can be moderated so that the servo reproducing heads RS1 to RS6 in the form of the thin film head can easily be manufactured.

Fig. 10 illustrates a third modification of the third embodiment. The third modification is arranged in such a manner that the servo reproducing heads RS1a to RS6a and RS1b to RS6b according to the first modification are disposed such that the odd heads are disposed on the substrate 2a and the even heads are disposed on the substrate 2b. Similarly to this the second modification, the degree of integration of the servo signal reproducing heads can be moderated so that the combination head can easily be manufactured.

According to the third embodiment, the servo signal reproducing heads RS1 to RS6 (RS1a to RS6a and RS1b to RS6b) are disposed so as to reproduce the servo signal from the tape edge portion of the servo region 8 (8 a and 8 b). The servo signal reproducing heads RS1 to RS6 (RS1a to RS6a and RS1b to RS6b) may be disposed so as to reproduce the servo signal from the tape center portion of the servo region 8 (8a and 8b).

A fourth embodiment of the present invention will be described with reference to Figs. 11 and 12.

A tracking control device according to the fourth embodiment comprises a combination head 43 for recording/reproducing information to a magnetic tape 41. The combination head 43 has a reflecting type photointerrupter holding member 44.

The magnetic tape 41 has a track group 42 composed of 48 tracks T_1 to T_{48} formed in the direction Y at the same intervals. According to this embodiment, width C of the magnetic tape 1 is arranged to be 1/4 inch and the track pitch is arranged to be 120 μm. The waving of the magnetic tape 41 is restricted to ± 50 μm or less by flanges (omitted from illustration) which restrict the ± Y directional end portions of the magnetic tape 41.

The combination head 43 recording heads W_1 to W_{16} in the form thin films and reproducing heads R_1 to R_{16}. The recording heads W_1 to W_{16} are disposed in the direction Y at a pitch of 360 μm. The reproducing heads R_1 to R_{16} are arranged in the direction X or - X to correspond to the recording heads W_1 to W_{16}. When the magnetic tape 1 is moved in the direction X, information is recorded by 8 recording heads W_1, W_3, W_5, W_7, W_9, W_{11}, W_{13} and W_{15}. When the magnetic tape 1 is moved in the direction - X, information is recorded by 8 recording heads W_2, W_4, W_6, W_8 W_{10}, W_{12}, W_{14} and W_{16}. Furthermore, the combination head 43 is moved in the direction - Y whenever the magnetic tape 41 reciprocates once. After the magnetic tape 41 has reciprocated three times, that is after the track switching operation has been performed three times, information can be recorded/reproduced from all of the 48 tracks T_1 to T_{48}.

The reflecting type photointerrupter holding member 44 has a reflecting type photointerrupter group 45 at a position confronting either of the + Y directional end of the magnetic tape 41, the reflecting type photointerrupter group 45 being composed of three reflecting type photointerrupters Sa_1 to Sa_3. As a result, light emitted from light emitting devices La_1 to La_3 is reflected by the magnetic tape 41 so as to be detected by light receiving devices Da_1 to Da_3. The light receiving devices Da_1 to Da_3 are positioned adjacent to the magnetic tape 1 while the light emitting devices La_1 to La_3 are positioned away from the magnetic tape 1.

The number of the reflecting type photointerrupters of the reflecting type photointerrupter group 45 is the same as the number of the tracks (T_1 to T_3) positioned in a range in which the pair of the recording head and

the reproducing head, that is, the recording head W_1 and the reproducing head R_1 are able to move. Since the reflecting type photointerrupter holding member 44 is integrally formed with the combination head 43, the reflecting type photointerrupters Sa1 to Sa3 are able to move in accordance with the movement of the combination head 43 in the direction ± Y. The length of the light emitting device is arranged to be 100 μm. The reflecting type photointerrupters Sa_1 to Sa_3 are disposed in the direction + Y at pitch d (d = 120 μm) which is the same as the track pitch of the magnetic tape 1 in such a manner that they are shifted in the direction + X so as not to overlap each other. The reflecting type photointerrupter Sa_1 is positioned in such a manner that the intermediate position between the light receiving device Da_1 of the reflecting type photointerrupter Sa_1 and the light emitting device La_1 aligns with the + Y directional end of the magnetic tape 1 when the recording head W_1 and the reproducing head R_1 are positioned to confront the track T_1.

The reflecting type photointerrupters Sa1 to Sa3 are, as shown in Fig. 12, connected to a head drive means 48 via a head drive control means 47. The head drive control means 47 comprises a reference voltage generator 49, a comparator 50 and a servo controller 51. The head drive means 48 comprises a motor driver 52 and a voice coil type linear motor 53. The comparator 50 compares the output from any of the reflecting type photointerrupters Sa_1 to Sa_3 and a predetermined reference level transmitted from the reference voltage generator 49. In order to make the difference, which is the result of the comparison, to be zero, a control signal is supplied from the servo controller 51 to the motor driver 52. As a result, the motor driver 52 rotates the voice coil type linear motor 53 so that the position of the combination head 43 is feedback-controlled. Thus, the head drive means 48 moves the combination head 43 in the ± Y direction of the magnetic head 41 so as to make the relative position between the magnetic tape 41 and the combination head 43 to be at a desired position.

When the above-described magnetic recording/reproducing apparatus reproduces data from all of the tracks T_1 to T_{48}, the combination head 43 is driven by the head drive means 48. As a result, the reproducing head R_1 and the track T_1, the reproducing head R_3 and the track T_7, the reproducing head R_5 and the track T_{13}, the reproducing head R_7 and the track T_{19}, the reproducing head R_9 and the track T_{25}, the reproducing head R_{11} and the track T_{31}, the reproducing head R_{13} and the track T_{37} and the reproducing head R_{15} and the track T_{43} respectively confront each other. At this time, the head drive control means 47 causes the head drive means 48 to move the combination head 43 so as to make the difference between the output from the reflecting type photointerrupter Sa_1 and the predetermined reference level to be zero. Furthermore, the combination head 43 is allowed to follow the waving of the magnetic tape 41 so that the relative position between the magnetic tape 41 and the combination head 43 is maintained at constant. When the magnetic tape 41 is moved in the direction X in this state, data is reproduced from tracks T_1, T_7, T_{13}, T_{19}, T_{25}, T_{31}, T_{37} and T_{43} by the reproducing heads R_1, R_3, R_5, R_7, R_9, R_{11}, R_{13} and R_{15}. After the data has been reproduced from the end of the magnetic tape 1, the magnetic tape 1 is moved in the direction - X, so that data is reproduced from the tracks T_4, T_{10}, T_{16}, T_{22}, T_{28}, T_{34}, T_{40} and T_{46} by the reproducing heads R_2, R_4, R_6, R_8, R_{10}, R_{12}, R_{14} and R_{16}.

After the data reproduction for one reciprocating operation has been completed, the combination head 43 is moved by the head drive means 48. As a result, the reproducing head R_1 and the track T_2, the reproducing head R_3 and the track T_8, the reproducing head R_5 and the track T_{14}, the reproducing head R_7 and the track T_{20}, the reproducing head R_9 and the track T_{26}, the reproducing head R_{11} and the track T_{32}, the reproducing head R_{13} and the track T_{38} and the reproducing head R_{15} and the track T_{44}, respectively confront each other. At this time, the head drive control means 47 causes the head drive means 48 to move the combination head 43 in order to make the difference between the output from the reflecting type photointerrupter Sa_2 and a predetermined reference level to be zero. When the magnetic tape 41 is moved in the direction X in this state, data is reproduced from the tracks T_2, T_8, T_{14}, T_{20}, T_{26}, T_{32}, T_{38} and T_{44} by the reproducing heads R_1, R_3, R_5, R_7, R_9, R_{11}, R_{13} and R_{15}. Then, the magnetic tape 41 is moved in the direction - X, data is reproduced from tracks T_5, T_{11}, T_{17}, T_{23}, T_{29}, T_{35}, T_{41} and T_{47}. When data is reproduced from the tracks T_3, T_9, T_{15}, T_{21}, T_{27}, T_{33}, T_{39} and T_{45} and T_6, T_{12}, T_{18}, T_{24}, T_{30}, T_{36}, T_{42} and T_{48}, the combination head 43 is moved in order to make the difference between the output from the reflecting type photointerrupter Sa_3 and a predetermined reference level to be zero. As a result, the track switching operation and the track following operation are performed so that data reproduction from all of the tracks T_1 to T_{48} is completed by the three times of the reciprocation motion of the magnetic tape 41. The recording operation is similarly performed.

Then, a first modification to the fourth embodiment of the present invention will be described with reference to Fig. 13. According to the first modification, a photointerrupter Sr for the reference output is disposed at a position which confronts a proper position of the magnetic tape 41 except for its end portion. A light receiving device Dr of the reflecting type photointerrupter Sr for the reference output is disposed on the + X side while a light emitting device Lr is disposed on the - X side.

The reflecting type photointerrupter Sr for the reference output is provided for the purpose of always monitoring reflection from the surface of the magnetic tape 1. In accordance with the output denoting the monitored surface reflection, the output from each of the reflecting type photointerrupter Sa_1 to Sa_3 is corrected. There-

fore, the tracking control cannot be influenced even if the output from each of the reflecting type photointerrupters Sa_1 to Sa_3 due to the change in the reflectance or the ambient temperature.

As an alternative to the structure arranged in such a manner that the output from each of the reflecting type photointerrupters Sa1 to Sa3 in accordance with the output from the reflecting type photointerrupter Sr for the reference output, the reference level may be corrected. Furthermore, another structure may be employed in which the feedback control is performed so as to make the output from each of the reflecting type photointerrupters Sa_1 to Sa_3 to be the half of the reflecting type photointerrupter Sr for the reference output.

A second modification of the fourth embodiment will be described with reference to Fig. 14. The second modification is arranged in such a manner that a reflecting type photointerrupter group 6 composed of three reflecting type photointerrupters Sb_1 to Sb_3 is provided at positions which correspond to the - Y directional end of the magnetic tape 41 in addition to the above-described reflecting type photointerrupter group 45. The reflecting type photointerrupter Sa_1 and the reflecting type photointerrupter Sb_1 are shifted from each other by a distance which corresponds to the width of the magnetic tape 41, that is, by 1/4 inch in the direction Y. The reflecting type photointerrupters Sa1 and Sb1 are positioned in such a manner that their centers coincides with each end portion of the ± Y directional ends of the magnetic tape 1 when the recording head W_1 and the reproducing head R_1 are positioned to confront the track T_1.

The feedback control is performed in such a manner that the difference between the outputs from the reflecting type photointerrupter pairs Sa_1 and Sb1, Sa_2 and Sb_2, and Sa_3 and Sb_3 is made to be zero. As a result, the head drive means moves the combination head 43 in the ± Y direction of the magnetic tape 41 so that the relative position between the magnetic tape 41 and the combination head 43 is held at a predetermined position. The apparatus according to the second modification reveals an advantage in that an influence from the reflectance of the magnetic tape or the temperature of the reflecting type photointerrupter can be relatively prevented with respect to the apparatus according to the first modification. Furthermore, the track switching operation and the track following operation can further stably be performed.

The above-described embodiments and the modifications are arranged in such a manner that the light receiving devices Da_1 to Da_3 and Db_1 to Db_3 are positioned adjacently to the magnetic tape 41 and the light emitting devices La_1 to La_3 and Lb_1 to Lb_3 are positioned away from the magnetic tape 41. However, they may be positioned inversely.

Claims

1. A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit (2a,2b) having a plurality of magnetic heads (W1-W8,R1-R8) is movable in the widthwise direction (Y) of a magnetic tape (1) to maintain tracking so that data recording/reproducing may be performed along a plurality of data tracks (T1-T48) formed on said magnetic tape (1) in parallel to a direction (X) in which said magnetic tape moves, said tracking control device comprising:

   at least two servo signal reproducing heads (RS1,RS2;RS1,RS2,RS3) provided integrally with said head unit (2a,2b) and provided for the purpose of reproducing servo signals for tracking use from a plurality of servo tracks (SV1-SV6;SV1-SV3) formed in parallel to said data tracks (T1-T48) on said magnetic tape (1), and

   movement control means (10-17) for controlling movement of said head unit (2a,2b) in said widthwise direction (Y) in accordance with the difference between two servo signals reproduced by two of said servo signal reproducing heads (RS1,RS2;RS1,RS2,RS3),

   characterised in that said head unit (2a-2b) is moveable between a plurality n of tracking positions so that for each magnetic head (W1-W8,R1-R8) data recording/reproducing may be performed along a plurality of said data tracks (T1-T6, T7-T12, ... T43-T48), wherein at each tracking position said movement control means (10-17) moves said head unit (2a-2b) according to the difference between two servo signals reproduced by two adjacent servo signal reproducing heads (RS1,RS2;RS1,RS2,RS3) and wherein a pitch (c;2c) of said servo tracks (SV1-SV6;SV1-SV3) is an integer multiple $K \geqq 1$ of the pitch (c) of said data tracks (T1-T48), the number of said servo tracks (SV1-SV6;SV1-SV3) is in the case of two servo heads and K = 1 the same and in the case of more than two servo heads and K > 1 smaller than the number n of said tracking positions and said servo signal reproducing heads (RS1,RS2;RS1,RS2,RS3) are disposed at substantially the same pitch (c) as said pitch of said data tracks (T1-T48) in said widthwise direction (Y).

2. A tracking control device according to claim 1 wherein said servo signals are recorded on said servo tracks (SV1-SV6;SV1-SV3) at different frequencies.

3. A tracking control device according to claim 1 or claim 2 wherein a servo signal recording head (7) for recording servo signals to said servo tracks (SV1-SV6;SV1-SV3) is provided for said head unit (2a,2b).

4. A tracking control device according to any one of claims 1 to 3 wherein the number of said tracking positions to be switched, n, satisfies the relationship in $n=\ell\cdot(m-1)$ where ℓ is the number of said servo tracks and m is the number of said servo signal reproducing heads.

5. A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit (2a,2b) having a plurality of magnetic heads (W1-W8,R1-R8) is moveable in the widthwise direction (Y) of a magnetic tape (1) to maintain tracking so that data recording/reproducing may be performed along a plurality of data tracks (T1-T48) formed on said magnetic tape (1) in parallel to a direction in which said magnetic tape moves (X), said tracking control device comprising:

servo signal reproducing heads (RS1-RS7) provided integrally with said head unit (2a,2b) and provided for the purpose of reproducing servo signals for tracking use; and

movement control means (21-26) for controlling movement of said head unit (2a,2b) in said widthwise direction (Y) in accordance with the difference in two servo signals reproduced by two of said servo signal reproducing heads (RS1-RS7), characterised in that

said head unit (2a,2b) is moveable between a plurality of tracking positions so that for each magnetic head (W1-W8,R1-R8) data recording/reproducing may be performed along a plurality of said data tracks (T1-T6, T7-T12 ... T43-T48), wherein at each track position said movement control means (21-26) moves said head unit (2a,2b) according to the difference between two servo signals reproduced by two adjacent servo signal reproducing heads (RS1-RS7) from a servo track (8;20) formed in parallel to said data tracks (T1-T48) on said magnetic tape (1), and wherein the number of said servo signal reproducing heads (RS1-RS7) is larger than, by one, the number of said tracking positions and said servo signal reproducing heads (RS1-RS7) are, in said widthwise direction (Y), disposed at substantially the same pitch (c) as the pitch of said data tracks (T1-T48).

6. A tracking control device according to claim 5 wherein a servo signal recording head (7) for recording servo signals to said servo track (8;20) is provided for said head unit (2a,2b).

7. A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit (2a,2b) having a plurality of magnetic heads (W1-W8,R1-R8) is moveable in the widthwise direction (Y) of a magnetic tape (1) to maintain tracking so that data recording/reproducing may be performed along a plurality of data tracks (T1-T48) formed on said magnetic tape in parallel to a direction (X) in which said magnetic tape moves, said tracking control device comprising:

servo signal reproducing heads (RS1-RS6) provided integrally with said head unit (2a,2b) and provided for the purpose of reproducing servo signals for tracking use recorded along said magnetic tape (1); and

movement control means (31-34) for controlling movement of said head unit (2a,2b) in said widthwise direction (Y) of said tape (1), characterised in that

said head unit (2a,2b) is moveable between a plurality of tracking positions so that for each magnetic head (W1-W8,R1-R8) data recording/reproducing may be performed along a plurality of said data tracks (T1-T7, ... T43-T48) wherein at each tracking position said movement control means (31-34) moves said head unit (2a,2b) in accordance with the difference between the level of the servo signal reproduced from a servo track (8;30) along one edge of said tape (1) by one of said servo signal reproducing heads (RS1-RS6) corresponding to that tracking position and a level of a predetermined reference signal, and wherein the number of said servo signal reproducing heads (RS1-RS6) is the same as the number of said tracking positions and said servo signal reproducing heads (RS1-RS6) are, in said widthwise direction (Y), disposed at substantially the same pitch (c) as the pitch of said data tracks (T1-T48).

8. A tracking control device according to claim 7 wherein a servo signal recording head (7) for recording servo signals to said servo tracks is provided for said head unit (2a,2b).

9. A tracking control device for a magnetic recording/reproducing apparatus arranged in such a manner that a head unit (2a,2b) having a plurality of magnetic heads (W1-W8,R1-R8) is moveable in a widthwise direction (Y) of a magnetic tape (1) to maintain tracking positions so that data recording/reproducing may be performed along a plurality of data tracks (T1-T48) formed on said magnetic tape in parallel to a direction (X) in which said magnetic tape (1) moves, said tracking control device comprising:

a plurality of servo signal reproducing heads (RS1a-RS6a,RS1b-RS6b) provided integrally with

said head unit (2a,2b) for tracking use; and

movement control means (33-36) for controlling movement of said head unit (2a,2b) in said widthwise direction in accordance with the difference between servo signals reproduced by two of said servo signal reproducing heads (RS1a-RS6a,RS1b-RS6b), characterised in that

said plurality of servo signal reproducing heads (RS1a-RS6a, RS1b-RS6b) comprise:

a first group of servo-signal reproducing heads (RS1a-RS6a) for reproducing servo signals (30a;8a) for tracking use recorded along one edge of said magnetic tape (1); and

a second group of servo-signal reproducing heads (RS1b-RS6b) for reproducing servo signals (30b;8b) for tracking use recorded along the other edge of said magnetic tape (1);

and in that said head unit (2a,2b) is moveable between a plurality of tracking positions so that for each magnetic head (W1-W8,R1-R8) data recording/reproducing may be performed along a plurality of said data tracks (T1-T7, ... T43-T48), wherein at each tracking position said movement control means moves said head unit (2a,2b) in accordance with the difference between the level of a servo signal (30a;8a) reproduced by one servo signal reproducing head (RS1a-RS6a) of said first group corresponding to that track position and the level of a servo signal (30b;8b) reproduced by a servo signal reproducing head (RS1b-RS6b) of the second group corresponding to that track position, and wherein the number of said servo-signal reproducing heads (RS1a-RS6a) of said first group and that (RS1b-RS6b) of said second group are the same as the number of said tracking positions and wherein servo-signal reproducing heads of said first group (RS1a-RS6a) and said second group (RS1b-RS6b) are, in the widthwise direction (Y), disposed at substantially the same pitch (c) as the pitch of said data tracks (T1-T48).

10. A tracking control device according to claim 9 wherein a servo signal recording head (7) for recording said servo signals (30a,30b;8a,8b) is provided for said head unit (2a,2b).

11. A tracking control device for a magnetic recording/reproducing apparatus having a combination head (43) including a plurality of magnetic heads (W1-W16,R1-R16) being arranged to perform data recording/reproducing along a plurality of data tracks (T1-T48) formed on a magnetic tape (41) in parallel to a direction (Y) in which the magnetic tape (41) moves, said tracking control device comprising:

a plurality of photointerrupters (45) for generating tracking control signals; and

movement control means for controlling movement of said combination head (43) in said widthwise direction (Y) in accordance with signals from said photointerrupters (45),

characterised in that said head unit is moveable between a plurality of tracking positions so that for each magnetic head (W1-W16,R1-R16) data recording/reproducing may be performed along a plurality of said data tracks (T1-T3, .. T46-T48) and in that each photointerrupter (45) is a reflecting type photointerrupter (45) for generating a signal indicating the intensity of light reflected from said magnetic tape (41) provided integrally with said combination head so as to oppose an edge of said magnetic tape at a respective tracking position, and in that said movement control means (47,48) controls the movement of said combination head (43) at each tracking position in accordance with the difference between the level of a signal generated by a reflecting type photointerrupter (45) and the level of a pre-determined reference signal, and in that the number of magnetic heads (W1-W16,R1-R16) is smaller than the number of data tracks (T1-T48) and the number of said reflecting type photointerrupters (45) is the same as the number of said tracking positions and said reflecting type photointerrupters (45) are disposed at substantially the same pitch (d) as the pitch of said data tracks (T1-T48).

12. A tracking control device according to claim 11 wherein each of said reflecting type photointerrupters (45) comprises a light emitting device (La1-La3) and a light receiving device (Da1-Da3).

13. A tracking control device according to claim 11 or claim 12 wherein said reference signal is transmitted from a reflecting type photointerrupter (Sr) provided for said combination head (43) for the purpose of detecting the intensity of light reflected from portions of said magnetic tape (41) other than the edges of said magnetic tape (41).

14. A tracking control device for a magnetic recording/reproducing apparatus having a combination head (43) including magnetic heads (W1-W16,R1-R16) arranged to perform data recording/reproducing along a plurality of data tracks (T1-T48) formed on said magnetic tape (41) in parallel to a direction in which the magnetic tape moves (X), said tracking control device comprising:

a plurality of photointerrupters (45,46) provided adjacent the edges of said magnetic tape (41) for generating tracking control signals; and

movem nt control means for controlling th movement of said combination head (43) in a widthwise dir ction (Y) in accordance with the diff rence betw n the l v l of a signal generated by on of said photoint rrupt rs (45) adjacent one dg and th lev l of a signal generated by on of said photointerrupters (46) adjac nt th oth r dge of said tape (41),

characterised in that said combination head (43) is moveable between a plurality of tracking positions so that for each magnetic head (W1-W16,R1-R16) data recording/reproducing may be performed along a plurality of said data tracks (T1-T3, ...T46-T48) and in that the photointerrupters (45,46) comprise first (45) and second (46) groups of reflecting type photointerrupters formed integrally with said combination head (43) for generating a signal indicating the intensity of light reflected from said magnetic tape (41), and wherein each photointerrupter (45) of the first group is positioned so as to oppose one edge of said magnetic tape (41) at a different one of said tracking positions, and each photointerrupter (46) of the second group is positioned so as to oppose the other edge of said magnetic tape at a different one of said tracking positions, and wherein said movement control means controls the movement of said combination head in a widthwise direction (Y) at each track position in accordance with the difference between the level of a signal generated by a photointerrupter (45) of the first group opposite one edge of the tape and the level of a signal generated by a photointerrupter (46) of the second group opposite the other edge of the tape (41), and wherein the number of said reflecting type photointerrupters (45) of said first group and that (46) of said second group are the same as the number of said tracking positions and said reflecting type photointerrupters of said first group (45) and said second group (46) are, in said widthwise direction (Y), disposed at substantially the same pitch (d) as the pitch of said data tracks (T1-T48).

15. A tracking control device according to claim 14 wherein each of said reflecting type photointerrupters (45,46) comprises a light emitting device (La1-La3,Lb1-Lb3) and a light receiving device (Da1-Da3,Db1-Db3).

16. A tracking control device according to any one of claims 1 to 16 wherein said magnetic heads (W1-W8,R1-R8) and said servo signal reproducing heads are formed as thin film heads made by a semiconductor process.

17. A tracking control device according to any one of claims 11 to 15 wherein said magnetic heads (W1-W16,R1-R16) are formed as thin film heads made by a semiconductor process.

Patentansprüche

1. Spurführung-Regelungsvorrichtung für ein magnetisches Aufzeichnungs-/Wiedergabegerät, das auf solche Weise ausgebildet ist, daß eine Kopfeinheit (2a, 2b) mit mehreren Magnetköpfen (W1-W8, R1-R8) in Breitenrichtung (Y) eines Magnetbands (1) verstellbar ist, um Spurnachführung aufrechtzuerhalten, damit das Aufzeichnen/Abspielen von Daten entlang mehrerer Datenspuren (T1-T48) ausgeführt werden kann, die auf dem Magnetband (1) parallel zur Richtung (X) ausgebildet sind, in der sich das Magnetband bewegt, mit:
   - mindestens zwei Servosignal-Abspielköpfen (RS1, RS2; RS1, RS2, RS3), die integral mit der Kopfeinheit (2a, 2b) ausgebildet sind und vorhanden sind, um Servosignale zur Verwendung bei der Spurführung aus mehreren Servospuren (SV1-SV6; SV1-SV3) abzuspielen, die parallel zu den Datenspuren (T1-T48) auf dem Magnetband (1) ausgebildet sind; und
   - einer Verstellregelungseinrichtung (10-17) zum Regeln der Verstellung der Kopfeinheit (2a, 2b) in der genannten Breitenrichtung (Y) abhängig von der Differenz zwischen zwei Servosignalen, wie sie durch zwei der Servosignal-Abspielköpfe (RS1, RS2; RS1, RS2, RS3) abgespielt werden;

   dadurch gekennzeichnet, daß die Kopfeinheit (2a-2b) zwischen mehreren Spurführungspositionen so verstellbar ist, daß für jeden Magnetkopf (W1-W8, R1-R8) das Aufzeichnen/Abspielen von Daten entlang mehreren der Datenspuren (T1-T6, T7-T12, ..., T43-T48) erfolgen kann, wobei die Verstellregelungseinrichtung (10-17) die Kopfeinheit (2a-2b) in jeder Spurführungsposition abhängig von der Differenz zwischen den zwei Servosignalen verstellt, die von zwei benachbarten Servosignal-Abspielköpfen (RS1, RS2; RS1, RS2, RS3) abgespielt werden, und wobei der Abstand (c; 2c) der Servospuren (SV1-SV6; SV1-SV3) ein ganzzahliges Vielfaches k ≧ 1 des Abstands (c) der Datenspuren (T1-T48) ist, die Anzahl der Servospuren (SV1-SV6; SV1-SV3) im Fall zweier Servoköpfe und k = 1 gleich groß ist wie, und im Fall von mehr als zwei Servoköpfen und k > 1 kleiner als die Anzahl n der Spurführungspositionen, und die Servosignal-Abspielköpfe (RS1, RS2; RS1, RS2, RS3) im we-

sentlichen mit dem Abstand (c) angeordnet sind, der dem Abstand der Datenspuren (T1-T48) in der genannten Breitenrichtung (Y) entspricht.

2. Spurführung-Regelungsvorrichtung nach Anspruch 1, bei der die Servosignale mit verschiedenen Frequenzen in den Servospuren (SV1-SV6; SV1-SV3) aufgezeichnet werden.

3. Spurführung-Regelungsvorrichtung nach Anspruch 1 oder Anspruch 2, bei der ein Servosignal-Aufzeichnungskopf (7) zum Aufzeichnen von Servosignalen in den Servospuren (SV1-SV6; SV1-SV3) für die Kopfeinheit (2a, 2b) vorhanden ist.

4. Spurführung-Regelungsvorrichtung nach einem der Ansprüche 1 bis 3, bei der die Anzahl n der umschaltbaren Spurführungspositionen der Beziehung $n = l \cdot (m-1)$ entspricht, wobei l die Anzahl der Servospuren und m die Anzahl der Servosignal-Abspielköpfe ist.

5. Spurführung-Regelungsvorrichtung für ein magnetisches Aufzeichnungs-/Wiedergabegerät, das auf solche Weise ausgebildet ist, daß eine Kopfeinheit (2a, 2b) mit mehreren Magnetköpfen (W1-W8, R1-R8) in Breitenrichtung (Y) eines Magnetbands (1) verstellbar ist, um Spurnachführung aufrechtzuerhalten, damit das Aufzeichnen/Abspielen von Daten entlang mehrerer Datenspuren (T1-T48) ausgeführt werden kann, die auf dem Magnetband (1) parallel zur Richtung (X) ausgebildet sind, in der sich das Magnetband bewegt, mit:
   - Servosignal-Abspielköpfen (RS1-RS7), die integral mit der Kopfeinheit (2a, 2b) ausgebildet sind und die vorhanden sind, um Servosignale zu Spurführungszwecken abzuspielen; und
   - einer Verstellregelungseinrichtung (21-26) zum Regeln der Verstellung der Kopfeinheit (2a, 2b) in der genannten Breitenrichtung (Y) abhängig von der Differenz zwischen zwei Servosignalen, die durch zwei der Servosignal-Abspielköpfe (RS1-RS7) abgespielt werden;

   dadurch gekennzeichnet, daß
   - die Kopfeinheit (2a, 2b) zwischen mehreren Spurführungspositionen so verstellbar ist, daß für jeden Magnetkopf (W1-W8, R1-R8) das Aufzeichnen/Abspielen von Daten entlang mehreren der Spuren (T1-T6, T7-T12, ..., T43-T48) ausgeführt werden kann, wobei die Verstellregelungseinrichtung (21-26) die Kopfeinheit (2a, 2b) in jeder Spurführungsposition abhängig von der Differenz zwischen den zwei Servosignalen verstellt, wie sie durch zwei benachbarte Servosignal-Abspielköpfe (RS1-RS7) aus einer Servospur (8; 20) abgespielt werden, die parallel zu den Datenspuren (T1-T48) auf dem Magnetband (1) ausgebildet sind, und wobei die Anzahl der Servosignal-Abspielköpfe (RS1-RS7) um eins größer ist als die Anzahl der Spurführungspositionen, und wobei die Servosignal-Abspielköpfe (RS1-RS7) in der genannten Breitenrichtung (Y) im wesentlichen mit demjenigen Abstand (c) angeordnet sind, der dem Abstand der Datenspuren (T1-T48) entspricht.

6. Spurführung-Regelungsvorrichtung nach Anspruch 5, bei der ein Servosignal-Aufzeichnungskopf (7) zum Lesen von Servosignalen in der Servospur (8; 20) für die Kopfeinheit (2a, 2b) vorhanden ist.

7. Spurführung-Regelungsvorrichtung für ein magnetisches Aufzeichnungs-/Wiedergabegerät, das auf solche Weise ausgebildet ist, daß eine Kopfeinheit (2a, 2b) mit mehreren Magnetköpfen (W1-W8, R1-R8) in Breitenrichtung (Y) eines Magnetbands (1) verstellbar ist, um Spurnachführung aufrechtzuerhalten, damit das Aufzeichnen/Abspielen von Daten entlang mehrerer Datenspuren (T1-T48) ausgeführt werden kann, die auf dem Magnetband (1) parallel zur Richtung (X) ausgebildet sind, in der sich das Magnetband bewegt, mit:
   - Servosignal-Abspielköpfen (RS1-RS6), die integral mit der Kopfeinheit (2a, 2b) ausgebildet sind und zum Abspielen von Servosignalen zum Gebrauch bei der Spurführung, welche Signale entlang dem Magnetband (1) aufgezeichnet sind, vorhanden sind; und
   - einer Verstellregelungseinrichtung (31-34) zum Regeln der Verstellung der Kopfeinheit (2a, 2b) in der genannten Breitenrichtung (Y) des Bands (1);

   dadurch gekennzeichnet, daß
   - die Kopfeinheit (2a, 2b) zwischen mehreren Spurführungspositionen so verstellbar ist, daß für jeden Magnetkopf (W1-W8, R1-R8) das Aufzeichnen/Abspielen von Daten entlang mehreren der Datenspuren (T1-T7, ..., T43-T48) ausgeführt werden kann, wobei die Verstellregelungseinrichtung (31-34) die Kopfeinheit (2a, 2b) in jeder Spurführungsposition abhängig von der Differenz zwischen dem Pegel des Servosignals, das von einer Servospur (8; 30), die entlang einer Kante des Bands (1) durch ein der Servosignal-Abspielköpfe (RS1-RS6), der dieser Spurführungsposition entspricht, und dem Pegel eines vorgegebenen Bezugssignals verstellt wird, und wobei die Anzahl der Servosignal-

Abspielköpf (RS1-RS6) mit der Anzahl der Spurführungspositionen übereinstimmt und die Servosignal-Abspielköpf (RS1-RS6) in der genannten Breitenrichtung (Y) im wesentlichen mit dem Abstand (c) angeordnet sind, der dem Abstand der Datenspuren (T1-T48) entspricht.

8. Spurführung-Regelungsvorrichtung nach Anspruch 7, bei der ein Servosignal-Aufzeichnungskopf (7) zum Aufzeichnen von Servosignalen in den Servospuren für die Kopfeinheit (2a, 2b) vorhanden ist.

9. Spurführung-Regelungsvorrichtung für ein magnetisches Aufzeichnungs-/Wiedergabegerät, das auf solche Weise ausgebildet ist, daß eine Kopfeinheit (2a, 2b) mit mehreren Magnetköpfen (W1-W8, R1-R8) in Breitenrichtung (Y) eines Magnetbands (1) verstellbar ist, um Spurnachführung aufrechtzuerhalten, damit das Aufzeichnen/Abspielen von Daten entlang mehrerer Datenspuren (T1-T48) ausgeführt werden kann, die auf dem Magnetband (1) parallel zur Richtung (X) ausgebildet sind, in der sich das Magnetband bewegt, mit:
   - mehreren Servosignal-Abspielköpfen (RS1a-RS6a, RS1b-RS6b), die integral mit der Kopfeinheit (2a, 2b) für Spurführungszwecke vorhanden sind; und
   - einer Verstellregelungseinrichtung (33-36) zum Regeln der Verstellung der Kopfeinheit (2a, 2b) in der genannten Breitenrichtung abhängig von der Differenz zwischen den Servosignalen, wie sie durch zwei der Servosignal-Abspielköpfe (RS1a-RS6a, RS1b-RS6b) abgespielt werden;
   dadurch gekennzeichnet, daß
   - die mehreren Servosignal-Abspielköpfe (RS1a-RS6a, RS1b-RS6b) folgendes aufweisen:
     – eine erste Gruppe von Servosignal-Abspielköpfen (RS1a-RS6a) zum Abspielen von Servosignalen (30a; 8a) für Spurführungszwecke, wie sie entlang einer Kante des Magnetbands (1) aufgezeichnet sind; und
     – eine zweite Gruppe von Servosignal-Abspielköpfen (RS1b-RS6b) zum Abspielen von Servosignalen (30b; 8b) für Spurführungszwecke, wie sie entlang der anderen Kante des Magnetbands (1) aufgezeichnet sind;
   - und daß die Kopfeinheit (2a, 2b) zwischen mehreren Spurführungspositionen so verstellbar ist, daß für jeden Magnetkopf (W1-W8, R1-R8) das Aufzeichnen/Abspielen von Daten entlang mehrerer der Datenspuren (T1-T7, ..., T43-T48) ausgeführt werden kann, wobei die Verstellregelungseinrichtung die Kopfeinheit (2a, 2b) in jeder Spurführungsposition abhängig von der Differenz zwischen dem Pegel eines Servosignals (30a; 8a), das durch einen Servosignal-Abspielkopf (RS1a-RS6a) der ersten Gruppe, der dieser Spurposition entspricht, und dem Pegel eines Servosignals (30b; 8b), das durch einen Servosignal-Abspielkopf (RS1b-RS6b) der zweiten Gruppe, der dieser Spurposition entspricht, abgespielt wird, verstellt und wobei die Anzahl der Servosignal-Abspielköpfe (RS1a-RS6a) der ersten Gruppe und diejenige (RS1b-RS6b) der zweiten Gruppe mit der Anzahl der Spurführungspositionen übereinstimmt und wobei die Servosignal-Abspielköpfe der ersten Gruppe (RS1a-RS6a) und der zweiten Gruppe (RS1b-RS6b) in der Breitenrichtung (Y) im wesentlichen mit einem Abstand (c) angeordnet sind, der dem Abstand der Datenspuren (T1-T48) entspricht.

10. Spurführung-Regelungsvorrichtung nach Anspruch 9, bei der ein Servosignal-Aufzeichnungskopf (7) zum Aufzeichnen der Servosignale (30a, 30b; 8a, 8b) für die Kopfeinheit (2a, 2b) vorhanden ist.

11. Spurführung-Regelungsvorrichtung für ein magnetisches Aufzeichnungs-/Wiedergabegerät mit einem Kombinationskopf (43) mit mehreren Magnetköpfen (W1-W16, R1-R16), die so angeordnet sind, daß sie das Aufzeichnen/Abspielen von Daten entlang mehreren Datenspuren (T1-T48) ausführen, die auf einem Magnetband (41) parallel zur Richtung (Y), in der das Magnetband (41) läuft, ausgebildet sind, mit:
   - mehreren Lichtschranken (45) zum Erzeugen von Spurführung-Regelungssignalen; und
   - einer Verstellregelungseinrichtung zum Regeln der Verstellung des Kombinationskopfs (43) in der genannten Breitenrichtung (Y) abhängig von Signalen von den Lichtschranken (45);
   dadurch gekennzeichnet, daß
   - die Kopfeinheit zwischen mehreren Spurführungspositionen so verstellbar ist, daß das Aufzeichnen/Abspielen von Daten für jeden Magnetkopf (W1-W16, R1-R16) entlang mehrerer der Datenspuren (T1-T3, ..., T46-T48) ausgeführt werden kann;
   - jede Lichtschranke (45) eine Reflexionslichtschranke (45) zum Erzeugen eines Signals ist, das die Intensität des am Magnetband (41) reflektierten Lichts ist, wobei die Lichtschranke integral mit dem Kombinationskopf ausgebildet ist, daß sie einer Kante des Magnetbands in einer jeweiligen Spurführungsposition gegenübersteht;
   - die Verstellregelungseinrichtung (47, 48) die Verstellung des Kombinationskopfs (43) in jeder Spur-

führungsposition abhängig von der Differenz zwischen dem Pegel eines von einer Reflexionslichtschranke (45) erzeugten Signals und dem Pegel eines vorgegebenen Bezugssignals verstellt; und

- die Anzahl von Magnetköpfen (W1-W16, R1-R16) kleiner als die Anzahl von Datenspuren (T1-T48) ist und die Anzahl der Reflexionslichtschranken (45) mit der Anzahl der Spurführungspositionen übereinstimmt und die Reflexionslichtschranken (45) im wesentlichen mit einem Abstand (d) angeordnet sind, der dem Abstand der Datenspuren (T1-T48) entspricht.

12. Spurführung-Regelungsvorrichtung nach Anspruch 11, bei der jede der Reflexionslichtschranken (45) eine Lichtemissionsvorrichtung (La1-La3) und eine Lichtempfangsvorrichtung (Da1-Da3) aufweist.

13. Spurführung-Regelungsvorrichtung nach Anspruch 11 oder Anspruch 12, bei der das Bezugssignal von einer Reflexionslichtschranke (Sr) geliefert wird, die für den Kombinationskopf (43) vorhanden ist, um die Intensität des Lichts zu erfassen, das aus anderen Bereichen des Magnetbands (41) als den Kanten des Magnetbands (41) reflektiert wird.

14. Spurführung-Regelungsvorrichtung für ein magnetisches Aufzeichnungs-/Wiedergabegerät mit einem Kombinationskopf (43) mit Magnetköpfen (W1-W16, R1-R16), die so angeordnet sind, daß sie das Aufzeichnen/Abspielen von Daten entlang mehreren Datenspuren (T1-T48) ausführen, die auf dem Magnetband (41) parallel zur Richtung (X), in der das Magnetband läuft, ausgebildet sind, mit:

- mehreren Lichtschranken (45, 46), die angrenzend an die Kanten des Magnetbands (41) vorhanden sind, um Spurführung-Regelungssignale zu erzeugen; und
- einer Verstellregelungseinrichtung zum Regeln der Verstellung des Kombinationskopfs (43) in Breitenrichtung (Y) abhängig von der Differenz zwischen dem Pegel eines Signals, das von einer der Lichtschranken (45), die angrenzend an eine Kante liegt, erzeugt wird, und dem Pegel eines Signals, das durch eine der Lichtschranken (46), die angrenzend an die andere Kante des Bands (41) liegt, erzeugt wird;

dadurch gekennzeichnet, daß

- der Kombinationskopf (43) zwischen mehreren Spurführungspositionen so verstellbar ist, daß für jeden Magnetkopf (W1-W16, R1-R16) das Aufzeichnen/Abspielen von Daten entlang mehrerer der Datenspuren (T1-T3, ..., T46-T48) ausgeführt werden kann;
- die Lichtschranken (45, 46) eine erste (45) und eine zweite (46) Gruppe von Reflexionslichtschranken aufweisen, die integral mit dem Kombinationskopf (43) ausgebildet sind, um ein Signal zu erzeugen, das die Intensität des vom Magnetband (41) reflektierten Lichts angibt, wobei jede Lichtschranke (45) der ersten Gruppe so positioniert ist, daß sie einer Kante des Magnetbands (41) in einer anderen der Spurführungspositionen gegenübersteht, und jede Lichtschranke (46) der zweiten Gruppe so positioniert ist, daß sie der anderen Kante des Magnetbands in einer anderen der Spurführungspositionen gegenübersteht;
- die Verstellregelungseinrichtung die Verstellung des Kombinationskopfs in Breitenrichtung (Y) in jeder Spurposition abhängig von der Differenz zwischen dem Pegel eines Signals, wie es von einer Lichtschranke (45) der ersten Gruppe, die einer Kante des Bands gegenübersteht, erzeugt wird, und dem Pegel eines Signals, das durch eine Lichtschranke (46) der zweiten Gruppe, die der anderen Kante des Bands (41) gegenübersteht, erzeugt wird, regelt; und
- die Anzahl der Reflexionslichtschranken (45) der ersten Gruppe und diejenige (46) der zweiten Gruppe (46) mit der Anzahl der Spurführungspositionen übereinstimmt und die Reflexionslichtschranken der ersten Gruppe (45) und der zweiten Gruppe (46) in der genannten Breitenrichtung (Y) im wesentlichen mit einem Abstand (d) angeordnet sind, der dem Abstand der Datenspuren (T1-T48) entspricht.

15. Spurführung-Regelungsvorrichtung nach Anspruch 14, bei der jede Reflexionslichtschranke (45, 46) eine Lichtemissionsvorrichtung (La1-La3, Lb1-Lb3) und eine Lichtempfangsvorrichtung (Da1-Da3, Db1-Db3) aufweist.

16. Spurführung-Regelungsvorrichtung nach einem der Ansprüche 1 bis 10, bei der die Magnetköpfe (W1-W8, R1-R8) und die Servosignal-Abspielköpfe als mittels eines Halbleiterprozesses hergestellte Dünnfilmköpfe ausgebildet sind.

17. Spurführung-Regelungsvorrichtung nach einem der Ansprüche 11 bis 15, bei der Magnetköpfe (W1-W16, R1-R16) als mittels eines Halbleiterprozesses hergestellte Dünnfilmköpfe ausgebildet sind.

Revendications

1. Dispositif de contrôle de suivi de piste pour un appareil d'enregistrement/reproduction magnétique conçu de telle façon qu'une unité formant tête (2a, 2b) comprenant plusieurs têtes magnétiques (W1-W8, R1-R8) est mobile dans le sens de la largeur (Y) d'une bande magnétique (1) pour maintenir un suivi de piste afin de permettre de réaliser un enregistrement/une reproduction de données le long de plusieurs pistes de données (T1-T48) formées sur ladite bande magnétique (1) parallèlement à une direction (X) dans laquelle ladite bande magnétique se déplace, ledit dispositif de contrôle de suivi de piste comprenant :

au moins deux têtes de reproduction de signaux d'asservissement (RS1, RS2 ; RS1, RS2, RS3) formées d'une manière solidaire avec ladite unité formant tête (2a, 2b) et prévues dans le but de reproduire des signaux d'asservissement destinés à être utilisés pour un suivi de piste, à partir de plusieurs pistes d'asservissement (SV1-SV6; SV1-SV3) formées parallèlement auxdites pistes de données (T1-T48) sur ladite bande magnétique (1), et

des moyens de commande de déplacement (10-17) destinés à commander un déplacement de ladite unité formant tête (2a, 2b) dans ledit sens de la largeur (Y) en fonction de la différence entre deux signaux d'asservissement reproduits par lesdites deux têtes de reproduction de signaux d'asservissement (RS1, RS2 ; RS1, RS2, RS3),

caractérisé en ce que ladite unité formant tête (2a, 2b) est mobile entre plusieurs n positions de suivi de piste afin que, pour chaque tête magnétique (W1-W8, R1-R8), il soit possible de réaliser un enregistrement/une reproduction de données le long de plusieurs desdites pistes de données (T1-T6, T7-T12,...T43-T48), en ce qu'à chaque position de suivi de piste, lesdits moyens de commande de déplacement (10-17) déplacent ladite unité formant tête (2a, 2b) en fonction de la différence entre deux signaux d'asservissement reproduits par deux têtes de reproduction de signaux d'asservissement (RS1, RS2 ; RS1, RS2, RS3) adjacentes, et en ce qu'un pas (c; 2c) desdites pistes d'asservissement (SV1-SV6 ; SV1-SV3) est un multiple entier $K \geqq 1$ du pas (c) desdites pistes de données (T1-T48), le nombre desdites pistes d'asservissement (SV1-SV6 ; SV1-SV3) étant, dans le cas de deux têtes de reproduction de signaux d'asservissement et où $K = 1$, égal et, dans le cas de plus de deux têtes de reproduction de signaux d'asservissement et où $K > 1$, inférieur au nombre n desdites positions de suivi de piste et lesdites têtes de reproduction de signaux d'asservissement (RS1, RS2 ; RS1, RS2, RS3) étant disposées suivant sensiblement le même pas (c) que lesdites pistes de données (T1-T48) dans ledit sens de la largeur (Y).

2. Dispositif de contrôle de suivi de piste selon la revendication 1, dans lequel lesdits signaux d'asservissement sont enregistrés sur lesdites pistes d'asservissement (SV1-SV6 ; SV1-SV3) à des fréquences différentes.

3. Dispositif de contrôle de suivi de piste selon la revendication 1 ou la revendication 2, dans lequel une tête d'enregistrement de signaux d'asservissement (7) destinée à enregistrer des signaux d'asservissement sur lesdites pistes d'asservissement (SV1-SV6 ; SV1-SV3) est prévue pour ladite unité formant tête (2a, 2b).

4. Dispositif de contrôle de suivi de piste selon l'une quelconque des revendications 1 à 3, dans lequel le nombre desdites positions de suivi de piste n à changer satisfait à la relation $n = \ell \cdot (m - 1)$ dans laquelle ℓ représente le nombre desdites pistes d'asservissement et m représente le nombre desdites têtes de reproduction de signaux d'asservissement.

5. Dispositif de contrôle de suivi de piste pour un appareil d'enregistrement/reproduction magnétique conçu de telle façon qu'une unité formant tête (2a, 2b) comportant plusieurs têtes magnétiques (W1-W8, R1-R8) est mobile dans le sens de la largeur (Y) d'une bande magnétique (1) pour maintenir un suivi de piste afin de permettre de réaliser un enregistrement/une reproduction de données le long de plusieurs pistes de données (T1-T48) formées sur ladite bande magnétique (1) parallèlement à une direction (X), dans laquelle ladite bande magnétique se déplace, ledit dispositif de contrôle de suivi de piste comprenant :

des têtes de reproduction de signaux d'asservissement (RS1-RS7) formées d'une manière solidaire avec ladite unité formant tête (2a, 2b) et prévues dans le but de reproduire des signaux d'asservissement servant à un suivi de piste ; t

des moyens de commande de déplacement (21-26) destinés à commander un déplacement de ladite unité formant tête (2a, 2b) dans ledit sens de la largeur (Y) en fonction de la différence entre deux signaux d'asservissement reproduits par lesdites deux têtes de reproduction de signaux d'asservissement (RS1-RS7), caractérisé en ce que

ladite unité formant tête (2a, 2b) est mobile entr plusieurs positions d suivi d piste afin que pour chaque têt magnétiqu (W1-W8, R1-R8) il soit possible d réaliser un enregistrement/un reproduction de données l long d plusieurs desdites pistes d données (T1-T6, T7-T12,... T43-T48), en ce qu'à chaqu position de suivi d piste, lesdits moyens de command d déplacement (21-26) déplacent ladite unité formant tête (2a, 2b) en fonction de la différence entre deux signaux d'asservissement reproduits par deux têtes de reproduction de signaux d'asservissement (RS1-RS7) adjacentes à partir d'une piste d'asservissement (8 ; 20) formée parallèlement auxdites pistes de données (T1-T48) de ladite bande magnétique (1), et en ce que le nombre desdites têtes de reproduction de signaux d'asservissement (RS1-RS7) est supérieur de un au nombre desdites positions de suivi de piste, lesdites têtes de reproduction de signaux d'asservissement (RS1-RS7) étant, dans ledit sens de la largeur (Y), disposées suivant sensiblement le même pas (c) que lesdites pistes de données (T1-T48).

6. Dispositif de contrôle de suivi de piste selon la revendication 5, dans lequel une tête d'enregistrement de signaux d'asservissement (7) destinée à enregistrer des signaux d'asservissement sur ladite piste d'asservissement (8; 20) est prévue pour ladite unité formant tête (2a, 2b).

7. Dispositif de contrôle de suivi de piste pour un appareil d'enregistrement/reproduction magnétique conçu de telle façon qu'une unité formant tête (2a, 2b) comportant plusieurs têtes magnétiques (W1-W8, R1-R8) est mobile dans le sens de la largeur (Y) d'une bande magnétique (1) pour maintenir un suivi de piste afin de permettre de réaliser un enregistrement/une reproduction de données le long de plusieurs pistes de données (T1-T48) formées sur ladite bande magnétique parallèlement à une direction (X) dans laquelle ladite bande magnétique se déplace, ledit dispositif de contrôle de suivi de piste comprenant :

des têtes de reproduction de signaux d'asservissement (RS1-RS6) formées d'une manière solidaire avec ladite unité formant tête (2a, 2b) et prévues dans le but de reproduire des signaux d'asservissement destinés à servir à un suivi de piste qui sont enregistrés le long de ladite bande magnétique (1) ; et

des moyens de commande de déplacement (31-34) destinés à commander un déplacement de ladite unité formant tête (2a, 2b) dans ledit sens de la largeur (Y) de ladite bande (1), caractérisé en ce que

ladite unité formant tête (2a, 2b) est mobile entre plusieurs positions de suivi de piste afin que pour chaque tête magnétique (W1-W8, R1-R8) il soit possible de réaliser un enregistrement/une reproduction de données le long de plusieurs desdites pistes de données (T1-T7, ... T43-T48), en ce qu'à chaque position de suivi de piste lesdits moyens de commande de déplacement (31-34) déplacent ladite unité formant tête (2a, 2b) en fonction de la différence entre le niveau du signal d'asservissement reproduit à partir d'une piste d'asservissement (8 ; 30) située le long de l'un des bords de ladite bande (1) par l'une desdites têtes de reproduction de signaux d'asservissement (RS1-RS6), correspondant à cette position de suivi de piste, et un niveau d'un signal de référence prédéterminé, et en ce que le nombre desdites têtes de reproduction de signaux d'asservissement (RS1-RS6) est identique au nombre desdites positions de suivi de piste, lesdites têtes de reproduction de signaux d'asservissement (RS1-RS6) étant, dans ledit sens de la largeur (Y), disposées suivant sensiblement le même pas (c) que lesdites pistes de données (T1-T48).

8. Dispositif de contrôle de suivi de piste selon la revendication 7, dans lequel une tête d'enregistrement de signaux d'asservissement (7) destinée à enregistrer des signaux d'asservissement sur lesdites pistes d'asservissement est prévue pour ladite unité formant tête (2a, 2b).

9. Dispositif de contrôle de suivi de piste pour un appareil d'enregistrement/reproduction magnétique conçu de telle façon qu'une unité formant tête (2a, 2b) comportant plusieurs têtes magnétiques (W1-W8, R1-R8) est mobile dans le sens de la largeur (Y) d'une bande magnétique (1) pour maintenir des positions de suivi de piste afin qu'il soit possible de réaliser un enregistrement/une reproduction de données le long de plusieurs pistes de données (T1-T48) formées sur ladite bande magnétique parallèlement à une direction (X) dans laquelle ladite bande magnétique (1) se déplace, ledit dispositif de contrôle de suivi de piste comprenant :

de multiples têtes de reproduction de signaux d'asservissement (RS1a-RS6a, RS1b-RS6b) form´s d'une manière s lidaire avec ladite unité formant t^t (2a, 2b) pour servir à un suivi de piste ; et

d s moyens d command d déplacem nt (33-36) destinés à command r un déplacem nt de ladite unité formant tête (2a, 2b) dans ledit sens d la largeur n foncti n de la différ nce ntre des signaux d'ass rviss ment r produits par l sdites deux têt s de r production d signaux d'asservissem nt (RS1a-RS6a, RS1b-RS6b), caractérisé en ce que

lesdites multiples têtes de reproduction de signaux d'asservissement (RS1a-RS6a, RS1b-RS6b) comprennent :

un premier groupe de têtes de reproduction de signaux d'asservissement (RS1a-RS6a) pour reproduire des signaux d'asservissement (30a ; 8a) destinés à servir à un suivi de piste qui sont enregistrés le long de l'un des bords de ladite bande magnétique (1) ; et

un second groupe de têtes de reproduction de signaux d'asservissement (KS1b-RS6b) pour reproduire des signaux d'asservissement (30b ; 8b) destinés à servir à un suivi de piste qui sont enregistrés le long de l'autre bord de ladite bande magnétique (1) ;

et en ce que ladite unité formant tête (2a, 2b) est mobile entre plusieurs positions de suivi de piste afin que pour chaque tête magnétique (W1-W8, R1-R8) il soit possible de réaliser un enregistrement/une reproduction de données le long de plusieurs desdites pistes de données (T1-T7, ...T43-T48), étant précisé qu'à chaque position de suivi de piste lesdits moyens de commande de déplacement déplacent ladite unité formant tête (2a, 2b) en fonction de la différence entre le niveau d'un signal d'asservissement (30a ; 8a) reproduit par l'une des têtes de reproduction de signaux d'asservissement (RS1a-RS6a) dudit premier groupe, correspondant à cette position de suivi de piste et le niveau d'un signal d'asservissement (30b ; 8b) reproduit par une tête de reproduction de signaux d'asservissement (RS1b-RS6b) du second groupe, correspondant à cette position de suivi de piste, et que le nombre desdites têtes de reproduction de signaux d'asservissement (RS1a-RS6a) dudit premier groupe et le nombre de celles (RS1b-RS6b) dudit second groupe sont identiques au nombre desdites positions de suivi de piste, les têtes de reproduction de signaux d'asservissement dudit premier groupe (RS1a-RS6a) et dudit second groupe (RS1b-RS6b) étant, dans le sens de la largeur (Y), disposées suivant sensiblement le même pas (c) que lesdites pistes de données (T1-T48).

10. Dispositif de contrôle de suivi de piste selon la revendication 9, dans lequel une tête d'enregistrement de signaux d'asservissement (7) destinée à enregistrer lesdits signaux d'asservissement (30a, 30b ; 8a, 8b) est prévue pour ladite unité formant tête (2a, 2b).

11. Dispositif de contrôle de suivi de piste pour un appareil d'enregistrement/reproduction magnétique comportant une tête mixte (43) comprenant plusieurs têtes magnétiques (W1-W16, R1-R16) conçues pour réaliser un enregistrement/une reproduction de données le long de plusieurs pistes de données (T1-T48) formées sur une bande magnétique (41) parallèlement à une direction (Y) dans laquelle la bande magnétique (41) se déplace, ledit dispositif de contrôle de suivi de piste comprenant :

plusieurs photo-interrupteurs (45) destinés à générer des signaux de commande de suivi de piste ; et

des moyens de commande de déplacement destinés à commander un déplacement de ladite tête mixte (43) dans ledit sens de la largeur (Y) en fonction de signaux provenant desdits photo-interrupteurs (45),

caractérisé en ce que ladite unité formant tête est mobile entre plusieurs positions de suivi de piste afin que pour chaque tête magnétique (W1-W16, R1-R16) il soit possible de réaliser un enregistrement/une reproduction de données le long de plusieurs desdites pistes de données (T1-T3, ... T46-T48), en ce que chaque photo-interrupteur (45) est un photo-interrupteur de type réflécteur (45) destiné à générer un signal indiquant l'intensité d'une lumière réfléchie à partir de ladite bande magnétique (41), qui est formé d'une manière solidaire avec ladite tête mixte afin de faire face à un bord de ladite bande magnétique au niveau d'une position de suivi de piste correspondante, en ce que lesdits moyens de commande de déplacement (47, 48) commandent le déplacement de ladite tête mixte (43) au niveau de chaque position de suivi de piste en fonction de la différence entre le niveau d'un signal généré par un photo-interrupteur de type réflécteur (45) et le niveau d'un signal de référence prédéterminé, et en ce que le nombre de têtes magnétiques (W1-W16, R1-R16) est inférieur au nombre de pistes de données (T1-T48) , tandis que le nombre desdits photo-interrupteurs de type réflécteur (45) est identique au nombre desdites positions de suivi de piste, lesdits photo-interrupteurs de type réflécteur (45) étant disposés suivant sensiblement le même pas (d) que lesdites pistes de données (T1-T48).

12. Dispositif de contrôle de suivi de piste selon la revendication 11, dans lequel chacun desdits photo-interrupteurs de type réflecteur (45) comprend un dispositif émetteur de lumière (La1-La3) et un dispositif récepteur de lumière (Da1-Da3).

13. Dispositif de contrôle de suivi de piste selon la revendication 11 ou la revendication 12, dans lequel ledit signal de référence est transmis à partir d'un photo-interrupteur de type réflecteur (Sr) prévu pour ladite

tête mixte (43) dans le but de détecter l'intensité de la lumière réfléchi à partir de portions d ladit band magnétique (41) autres qu les bords de ladite band magnétiqu (41).

14. Dispositif de contrôl d suivi d pist pour un appar il d' nregistrem nt/r production magnétiqu comportant une tête mixte (43) comprenant des têtes magnétiques (W1-W16, R1-R16) conçues pour réaliser un enregistrement/une reproduction de données le long de plusieurs pistes de données (T1-T48) formées sur ladite bande magnétique (41) parallèlement à une direction (X) dans laquelle la bande magnétique se déplace, ledit dispositif de contrôle de suivi de piste comprenant :

plusieurs photo-interrupteurs (45, 46) disposés à proximité des bords de ladite bande magnétique (41) pour générer des signaux de commande de suivi de piste ; et

des moyens de commande de déplacement destinés à commander le déplacement de ladite tête mixte (43) dans le sens de la largeur (Y) en fonction de la différence entre le niveau d'un signal généré par l'un desdits photo-interrupteurs (45) situés à proximité de l'un des bords et le niveau d'un signal généré par l'un desdits photo-interrupteurs (46) situés à proximité de l'autre bord de ladite bande (41),

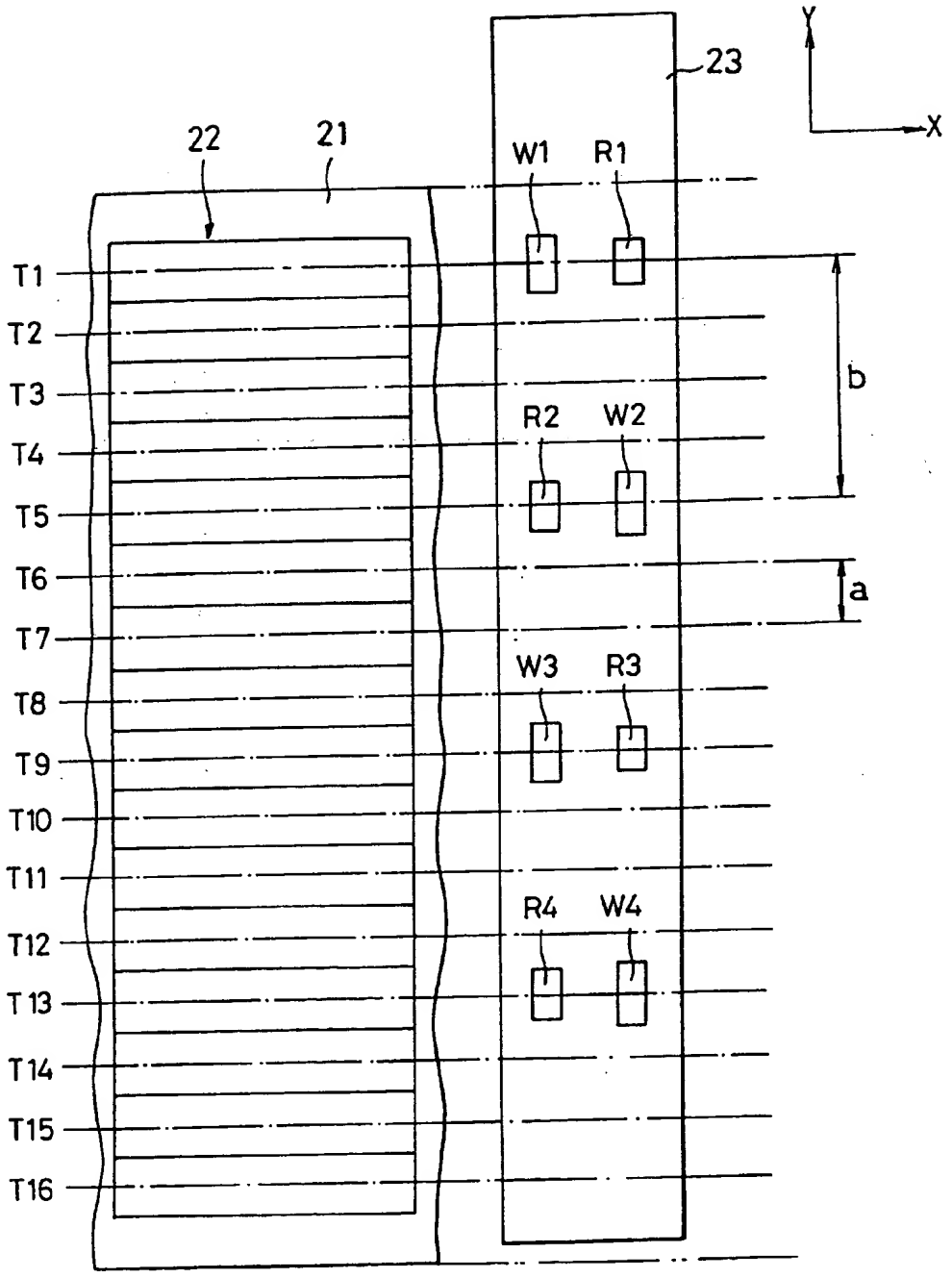
caractérisé en ce que ladite tête mixte (43) est mobile entre plusieurs positions de suivi de piste afin que pour chaque tête magnétique (W1-W16, R1-R16) il soit possible de réaliser un enregistrement/une reproduction de données le long de plusieurs desdites pistes de données (T1-T3, ... T46-T48), en ce que les photo-interrupteurs (45, 46) comprennent des premier (45) et second (46) groupes de photo-interrupteurs de type réflécteur formés d'une manière solidaire avec ladite tête mixte (43) pour générer un signal indiquant l'intensité d'une lumière réfléchie à partir de ladite bande magnétique (41), en ce que chaque photo-interrupteur (45) du premier groupe est positionné de manière à faire face à l'un des bords de ladite bande magnétique (41) au niveau d'une position de suivi de piste différente parmi lesdites positions de suivi de piste, et chaque photo-interrupteur (46) du second groupe est positionné de manière à faire face à l'autre bord de ladite bande magnétique au niveau d'une position de suivi de piste différente parmi lesdites positions de suivi de piste, en ce que lesdits moyens de commande de déplacement commandent le déplacement de ladite tête mixte dans le sens de la largeur (Y) au niveau de chaque position de suivi de piste en fonction de la différence entre le niveau d'un signal généré par un photo-interrupteur (45) du premier groupe situé en face de l'un des bords de la bande et le niveau d'un signal généré par un photo-interrupteur (46) du second groupe situé en face de l'autre bord de la bande (41), et en ce que le nombre desdits photo-interrupteurs de type réflécteur (45) dudit premier groupe et le nombre de ceux (46) dudit second groupe sont identiques au nombre desdites positions de suivi de piste, lesdits photo-interrupteurs de type réflécteur dudit premier groupe (45) et dudit second groupe (46) étant, dans ledit sens de la largeur (Y), disposés suivant sensiblement le même pas (d) que lesdites pistes de données (T1-T48).

15. Dispositif de contrôle de suivi de piste selon la revendication 14, dans lequel chacun desdits photo-interrupteurs de type réflecteur (45, 46) comprend un dispositif émetteur de lumière (La1-La3, Lb1-Lb3) et un dispositif récepteur de lumière (Da1-Da3, Db1-Db3).

16. Dispositif de contrôle de suivi de piste selon l'une quelconque des revendications 1 à 10, dans lequel lesdites têtes magnétiques (W1-W8, R1-R8) et lesdites têtes de reproduction de signaux d'asservissement sont réalisées sous la forme de têtes à couches minces fabriquées par un procédé d'élaboration de semi-conducteurs.

17. Dispositif de contrôle de suivi de piste selon l'une quelconque des revendications 11 à 15, dans lequel lesdites têtes magnétiques (W1-W16, R1-R16) sont réalisées sous la forme de têtes à couches minces fabriquées par un procédé d'élaboration de semi-conducteurs.

Fig. 1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21
W1
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T16
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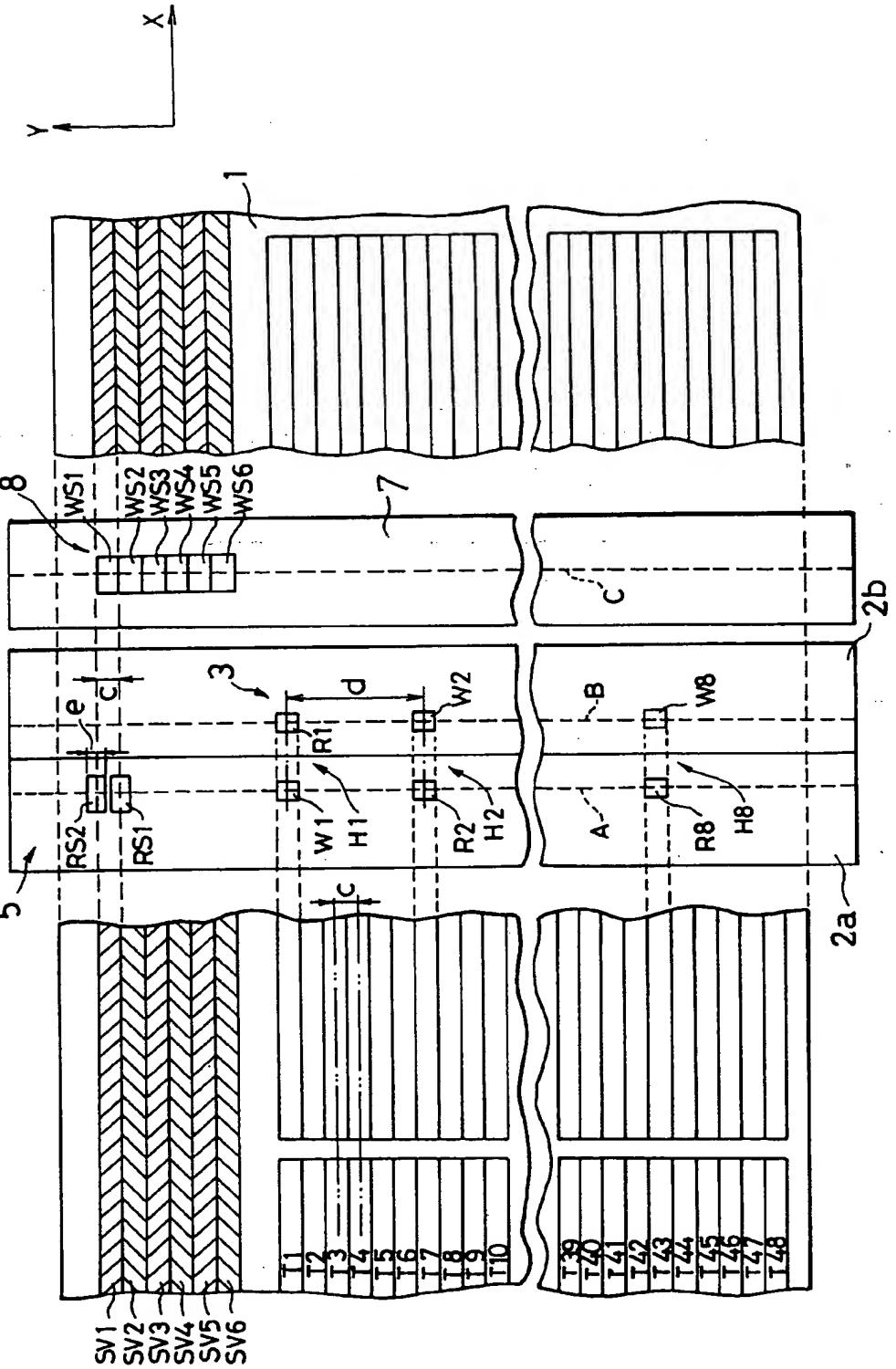
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WS4
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d
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T48

Fig. 2A

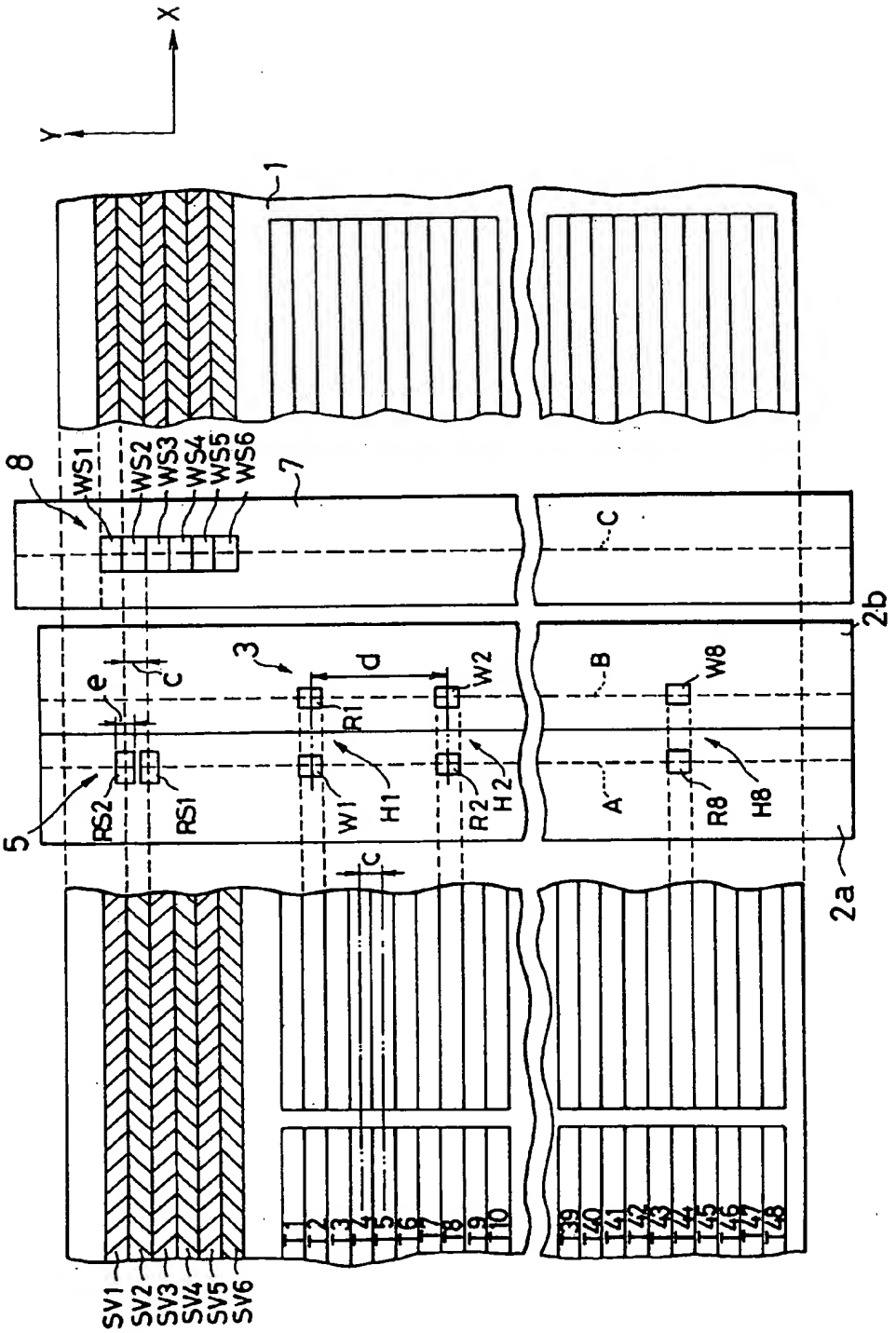

X
Y
1
8
WS1
WS2
WS3
WS4
WS5
WS6
7
C
2b
3
d
W2
e
c
B
W8
R1
W1
H1
R2
H2
A
R8
H8
5
RS2
RS1
2a
SV1
SV2
SV3
SV4
SV5
SV6
T1
T2
T3
T4
T5
T6
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 2B

Fig. 3

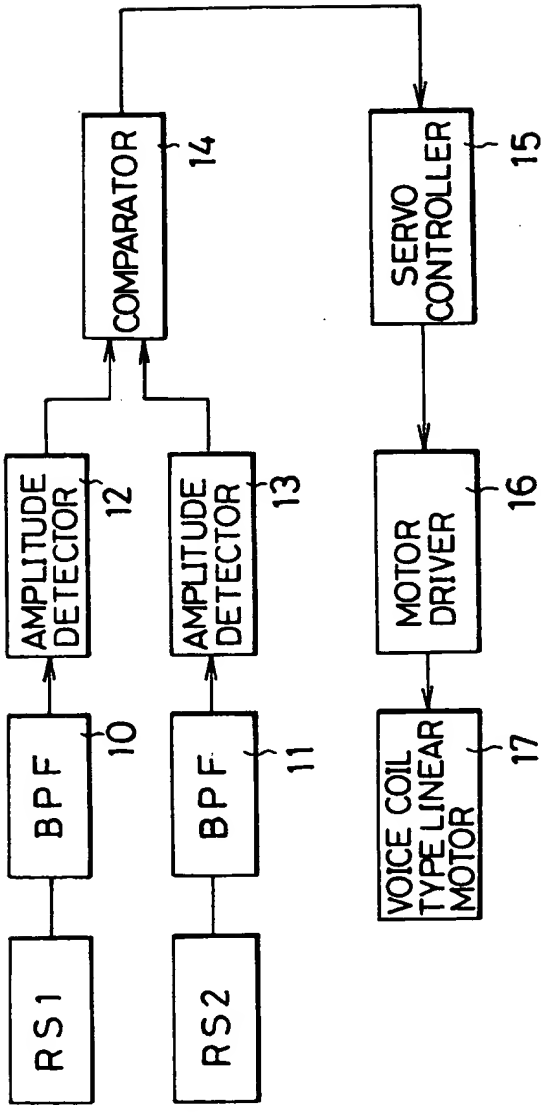
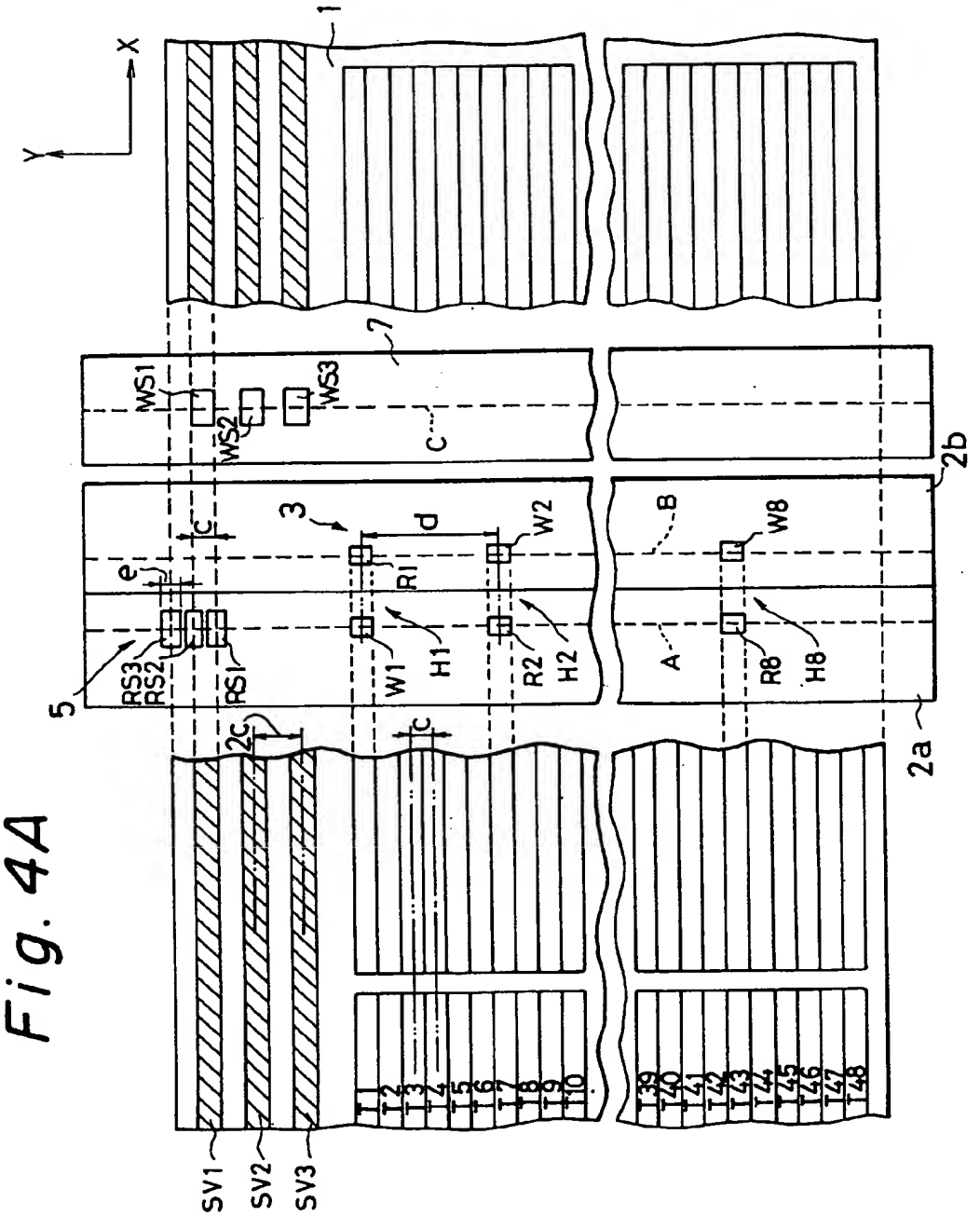

RS1
RS2
BPF
BPF
10
11
AMPLITUDE DETECTOR
AMPLITUDE DETECTOR
12
13
COMPARATOR
14
SERVO CONTROLLER
15
MOTOR DRIVER
16
VOICE COIL TYPE LINEAR MOTOR
17

Fig. 4A


X
Y
1
7
WS1
WS2
WS3
C
2b
3
d
W2
W8
B
e
C
R1
RS3
RS2
RS1
W1
H1
R2
H2
A
R8
H8
5
2a
2c
C
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48
SV1
SV2
SV3

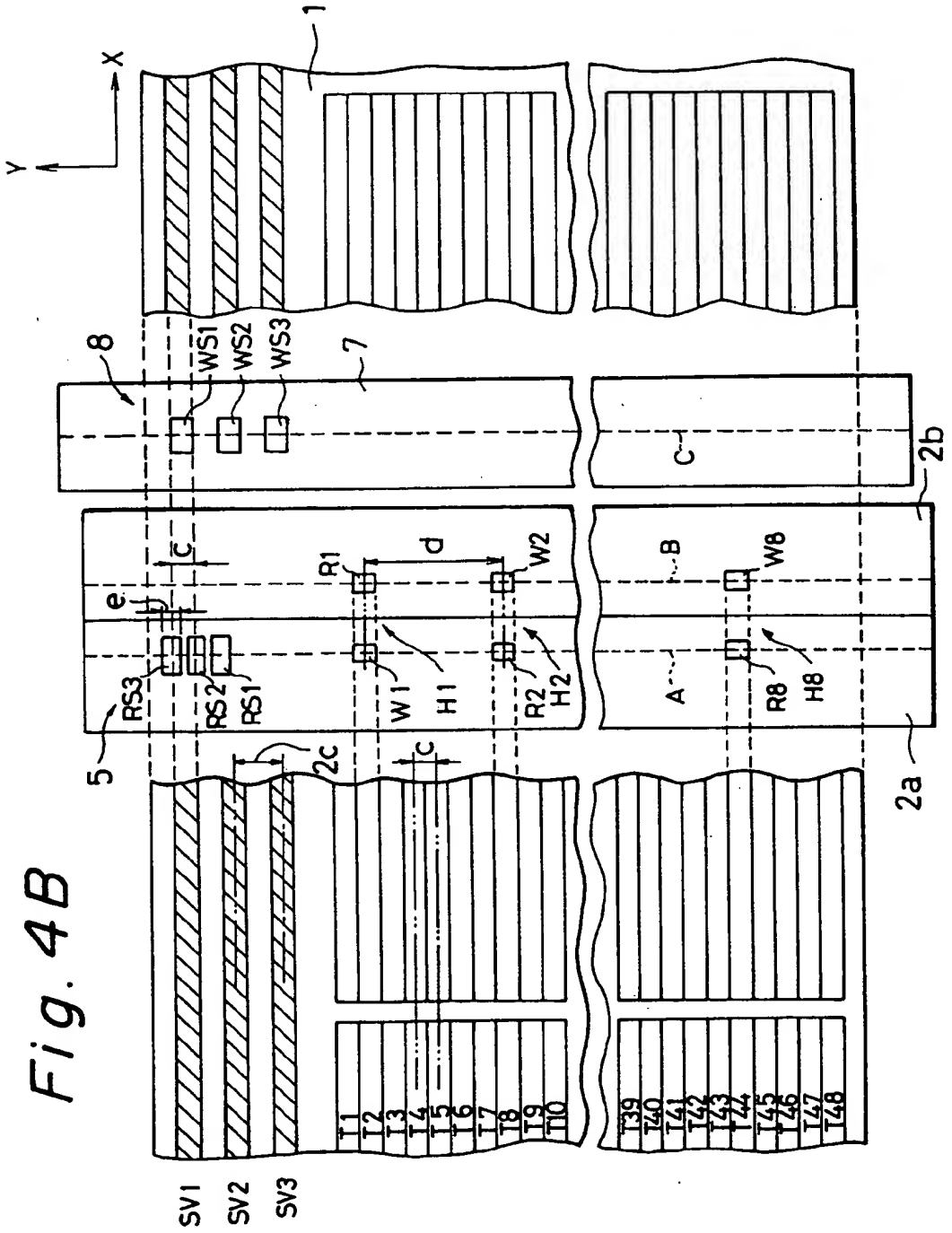

X
Y
1
8
WS1
WS2
WS3
7
2b
C
B
W8
A
R8
H8
c
e
d
R1
W2
W1
H1
R2
H2
RS3
RS2
RS1
5
2c
2a
SV1
SV2
SV3
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 4B

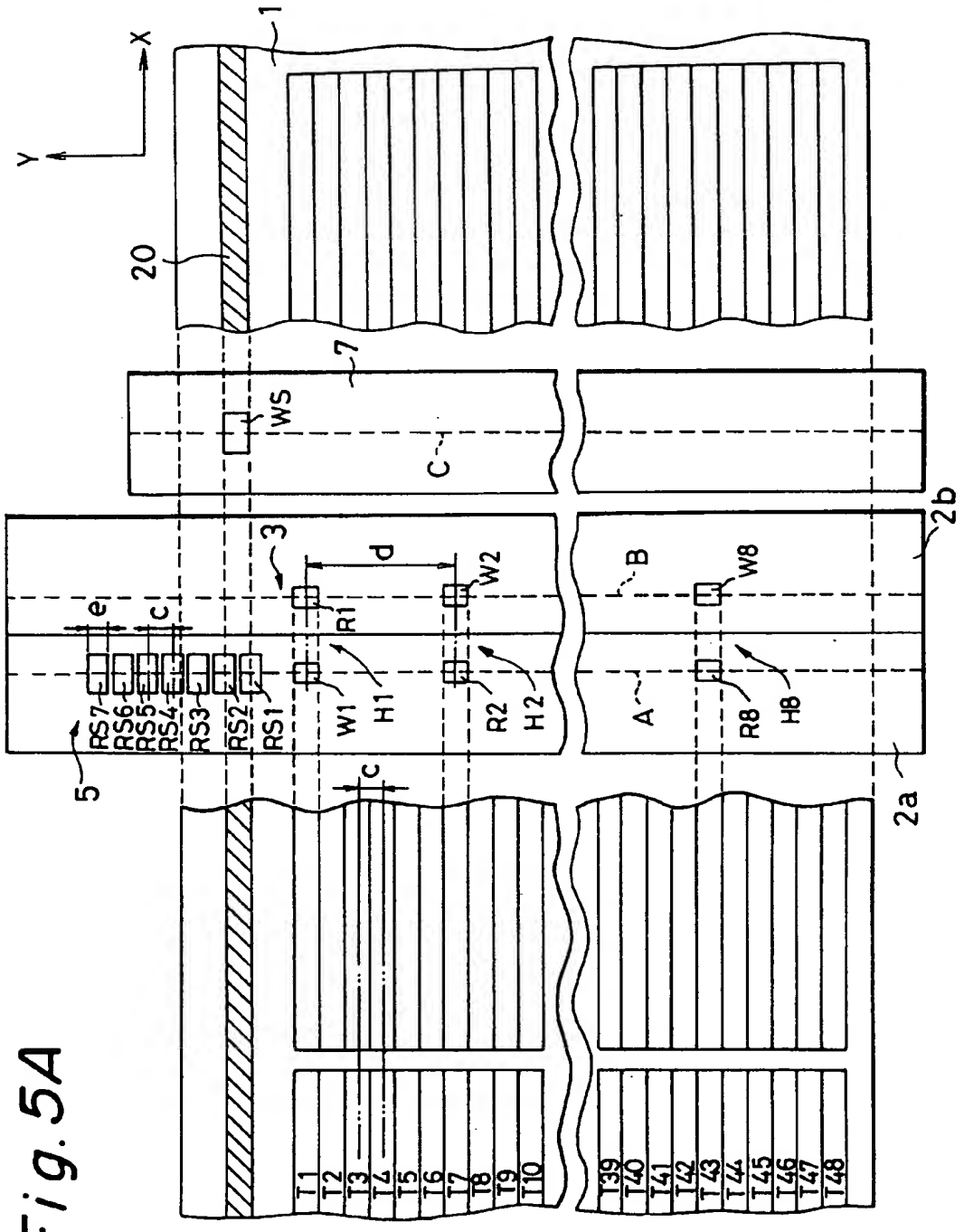
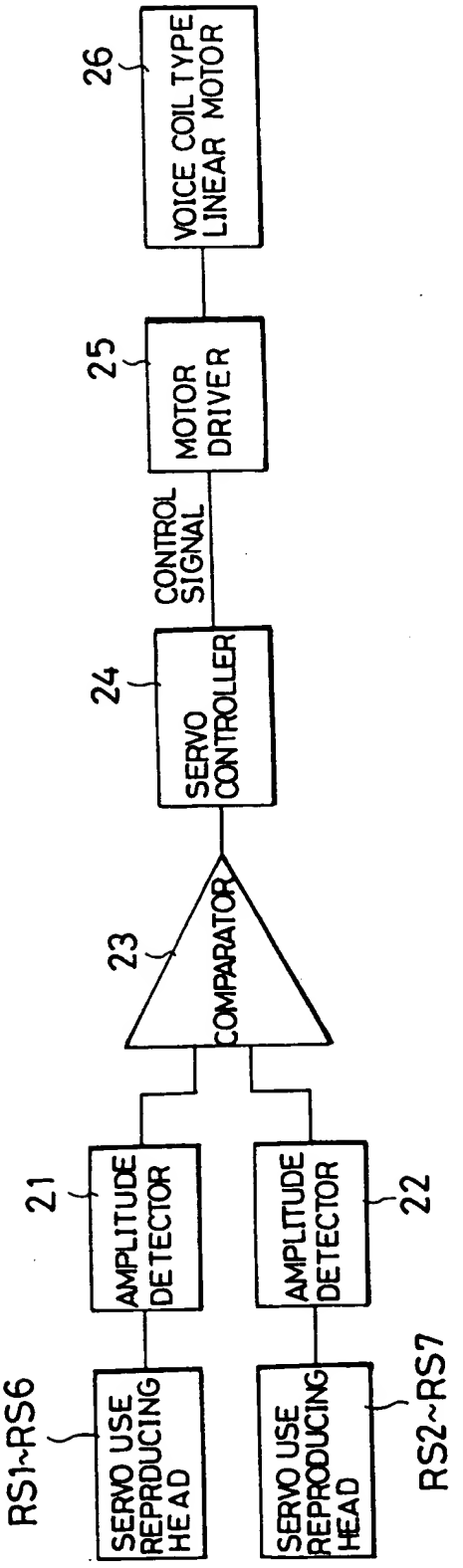

X
Y
1
20
7
WS
C
3
d
W2
R1
W1
H1
R2
H2
B
W8
R8
H8
A
e
c
RS7
RS6
RS5
RS4
RS3
RS2
RS1
5
2b
2a
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 5A

Fig. 5B


26
VOICE COIL TYPE LINEAR MOTOR
25
MOTOR DRIVER
CONTROL SIGNAL
24
SERVO CONTROLLER
23
COMPARATOR
21
AMPLITUDE DETECTOR
22
AMPLITUDE DETECTOR
RS1~RS6
SERVO USE REPRODUCING HEAD
SERVO USE REPRODUCING HEAD
RS2~RS7

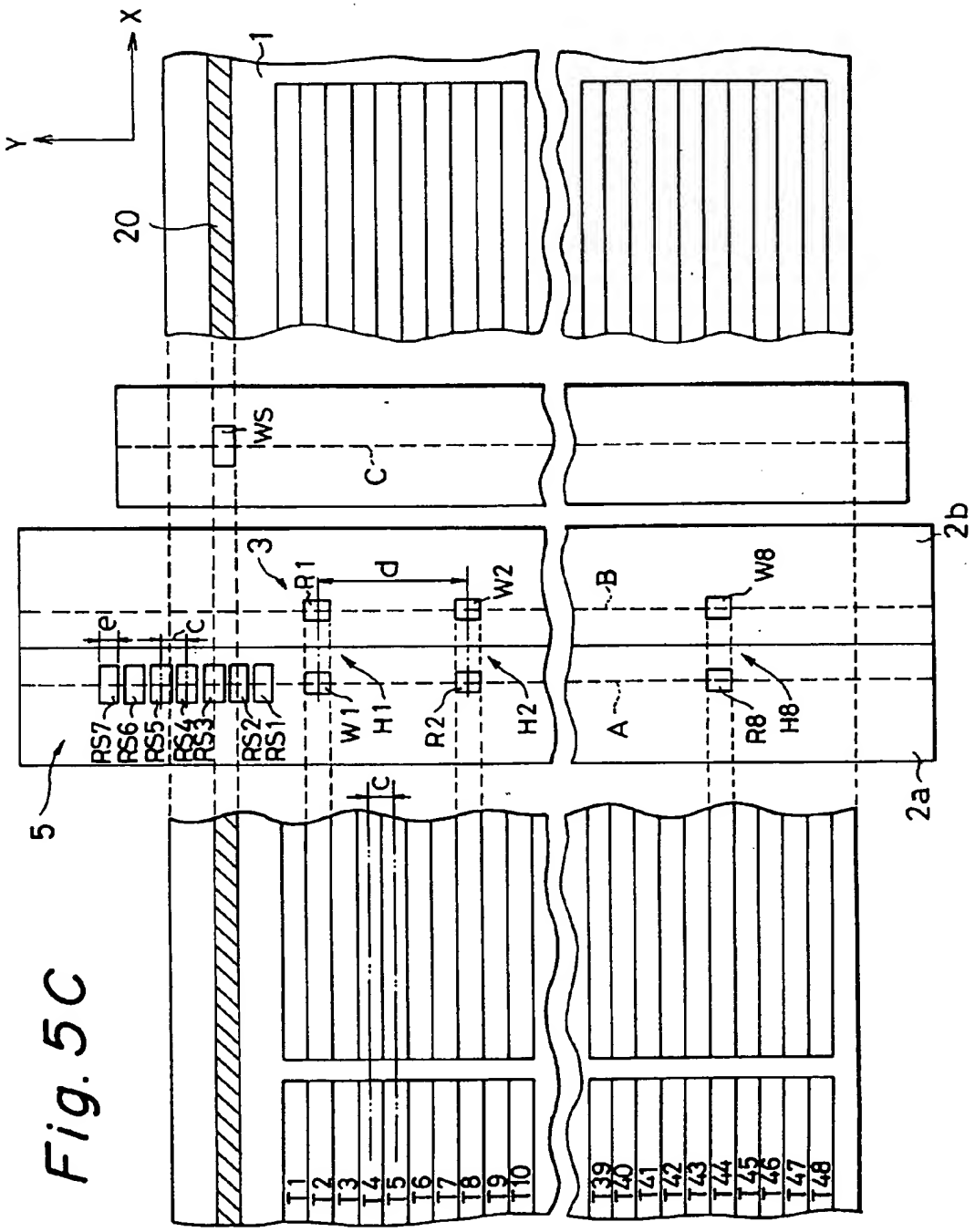

X
Y
1
20
WS
C
3
R1
d
W2
B
W8
2b
e
c
RS7
RS6
RS5
RS4
RS3
RS2
RS1
W1
H1
R2
H2
A
R8
H8
5
2a
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 5C

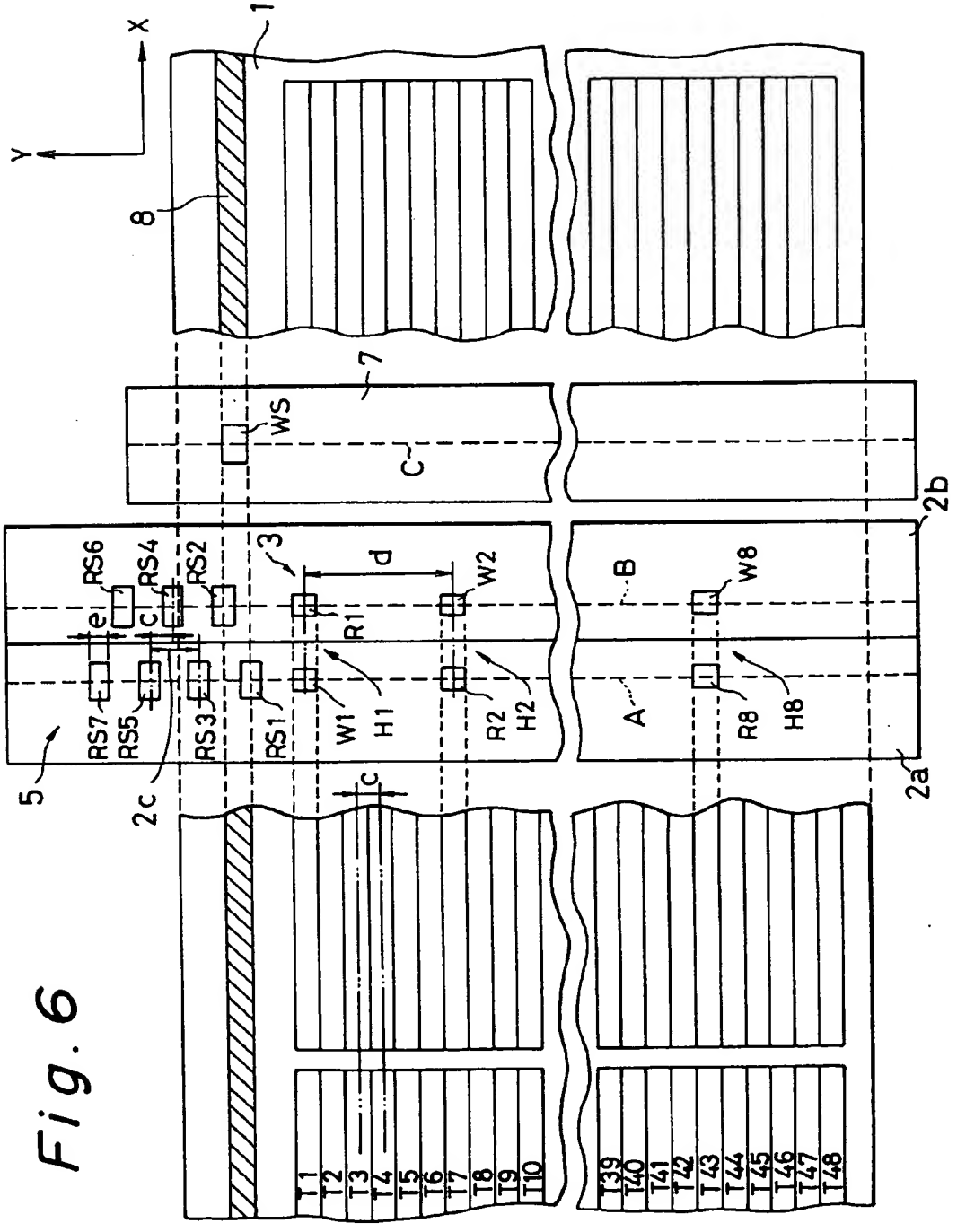

X
Y
1
8
7
WS
C
2b
3
d
W2
RS6
RS4
RS2
e
c
R1
B
W8
RS7
RS5
RS3
RS1
W1
H1
R2
H2
A
R8
H8
5
2c
2a
c
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 6

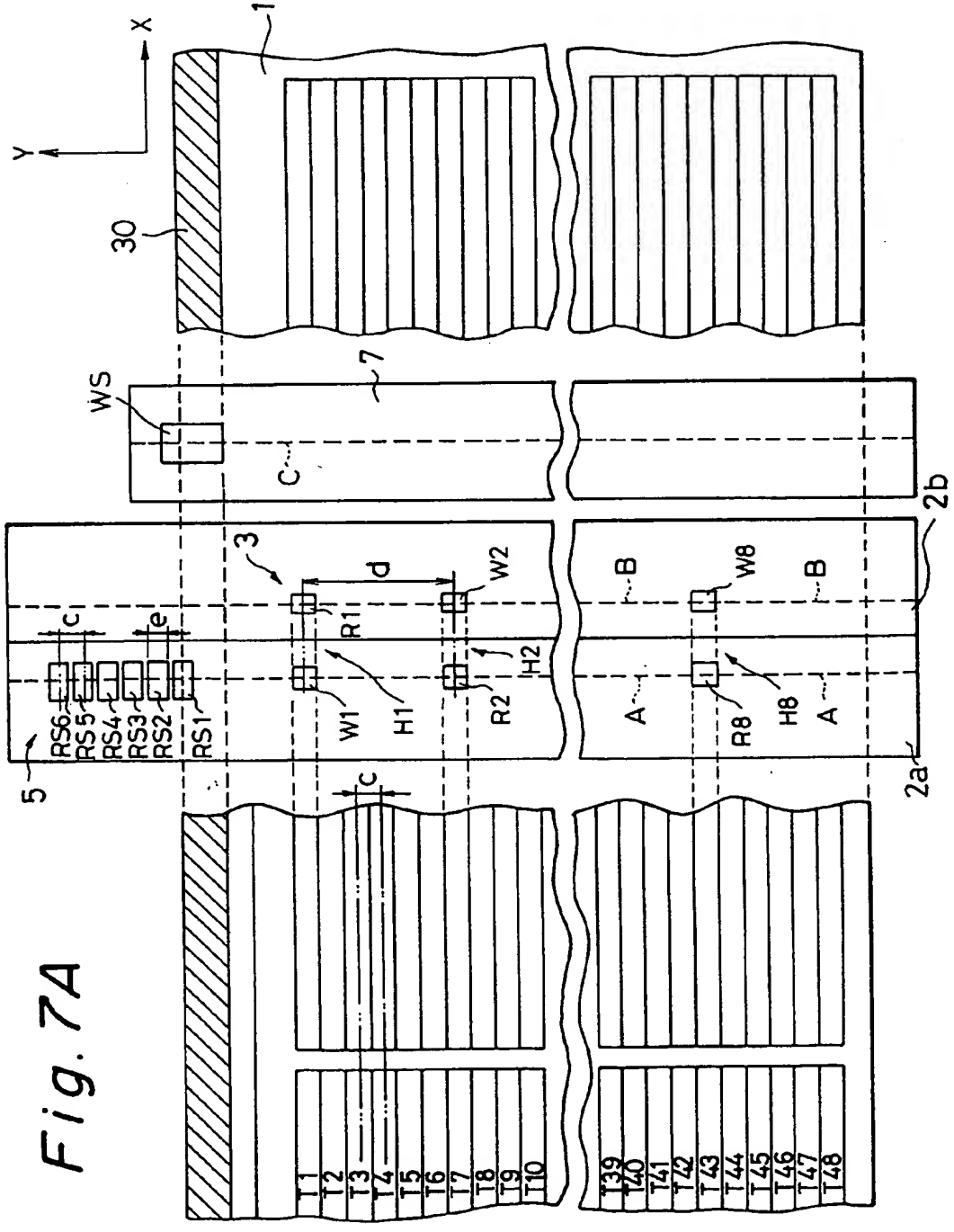
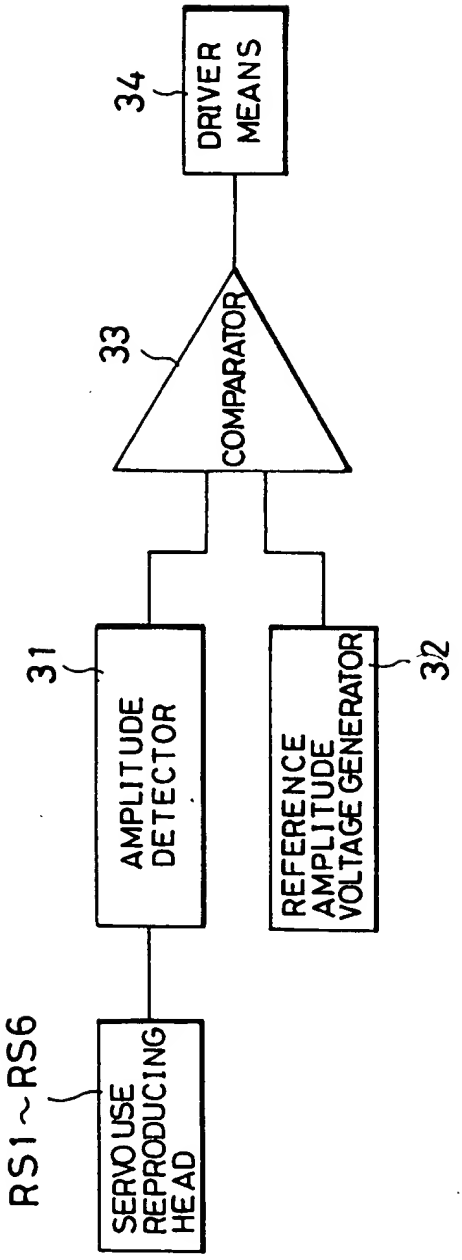

X
Y
1
30
7
WS
C
2b
3
d
W2
B
W8
B
c
e
R1
H2
RS6
RS5
RS4
RS3
RS2
RS1
W1
H1
R2
A
R8
H8
A
5
2a
c
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 7A

Fig. 7B


RS1~RS6
SERVO USE REPRODUCING HEAD
31
AMPLITUDE DETECTOR
32
REFERENCE AMPLITUDE VOLTAGE GENERATOR
33
COMPARATOR
34
DRIVER MEANS

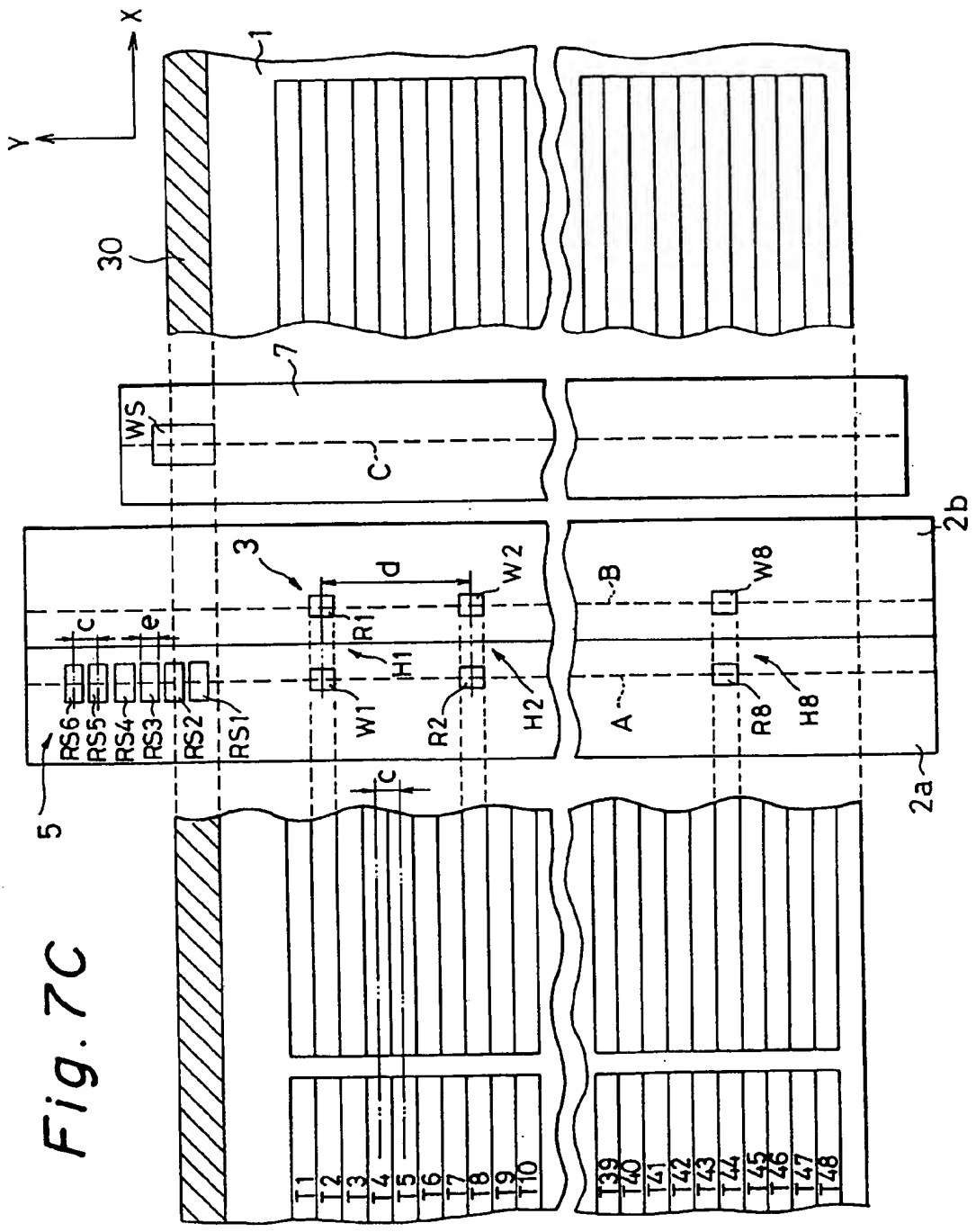

X
Y
1
30
7
WS
C
3
d
W2
B
W8
2b
c
e
R1
H1
W1
R2
H2
A
R8
H8
RS6
RS5
RS4
RS3
RS2
RS1
5
2a
c
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 7C

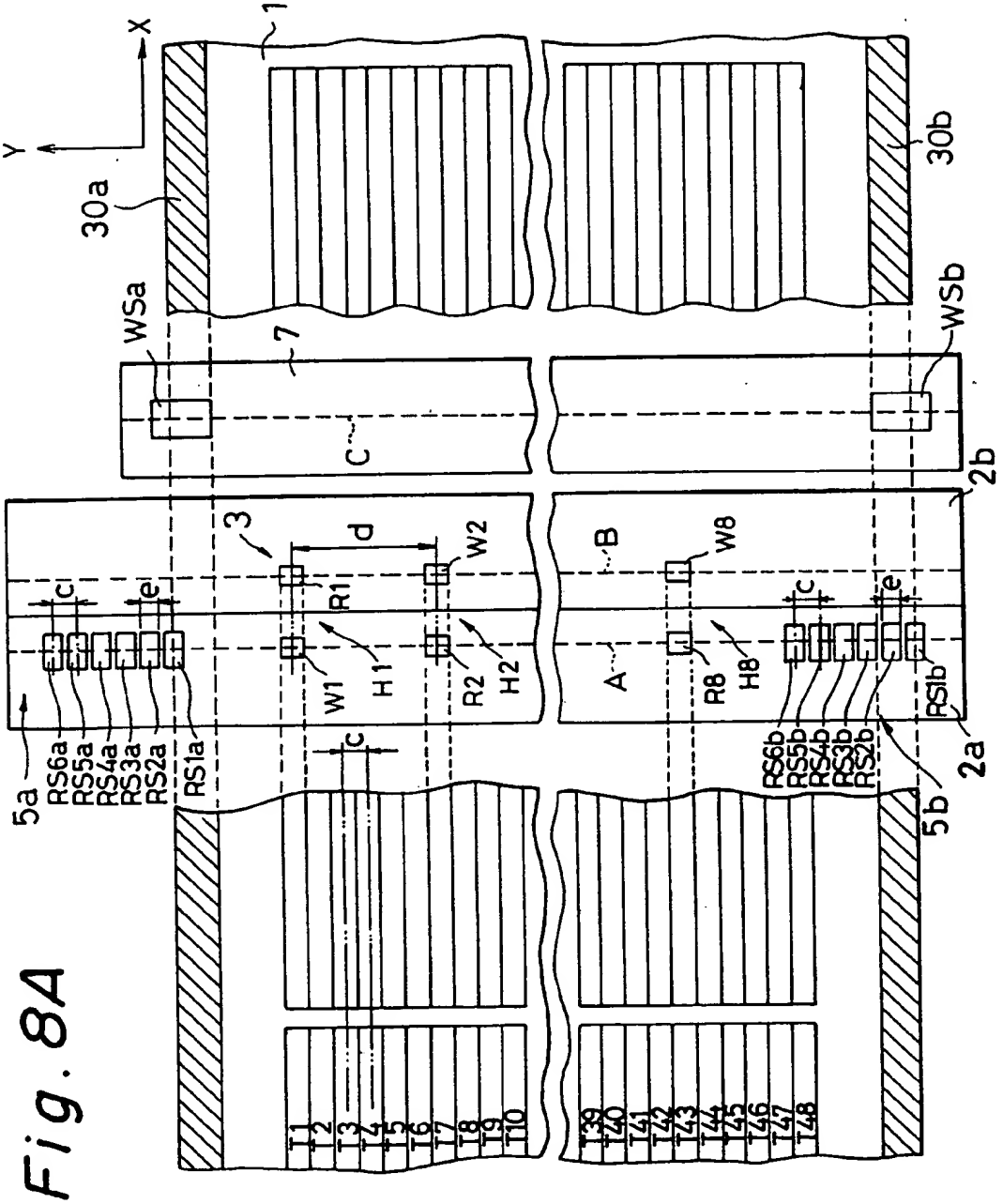
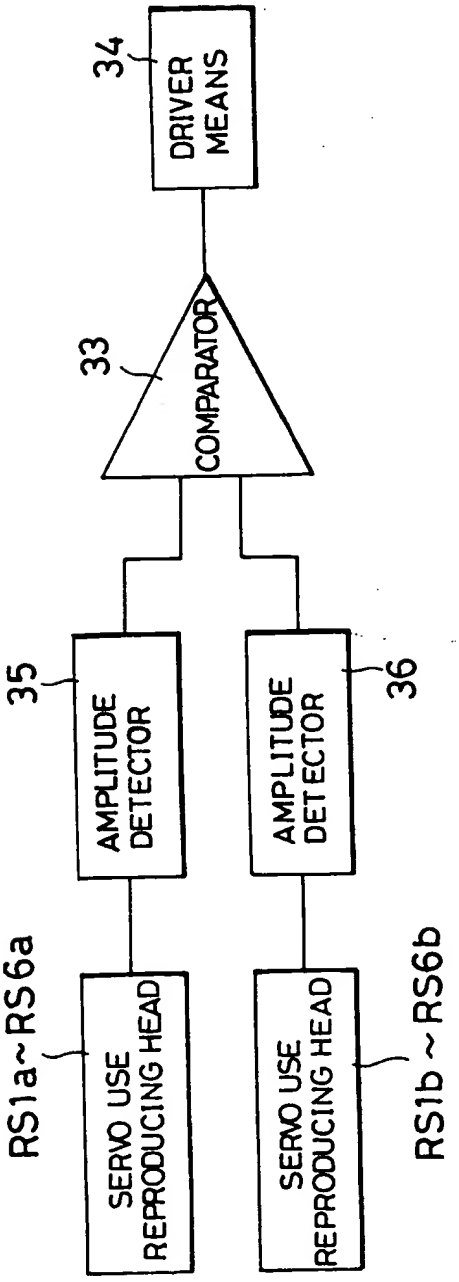

X
Y
1
30a
30b
WSa
WSb
7
C
2b
3
d
W2
W1
H1
R1
R2
H2
B
W8
A
R8
H8
c
e
RS6a
RS5a
RS4a
RS3a
RS2a
RS1a
5a
RS6b
RS5b
RS4b
RS3b
RS2b
RS1b
2a
5b
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 84

Fig. 8B


34
DRIVER MEANS
33
COMPARATOR
35
AMPLITUDE DETECTOR
36
AMPLITUDE DETECTOR
RS1a~RS6a
SERVO USE REPRODUCING HEAD
SERVO USE REPRODUCING HEAD
RS1b~RS6b

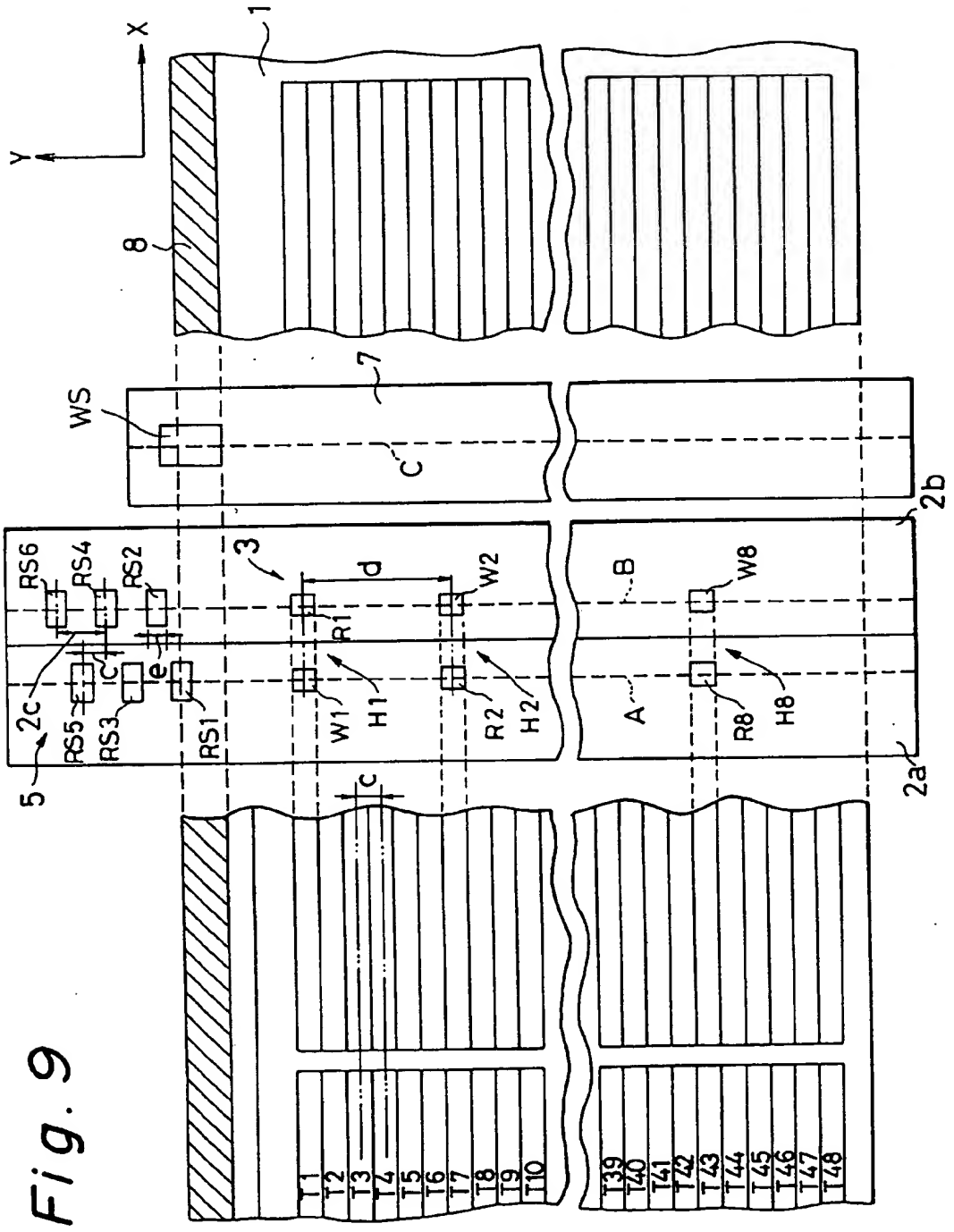
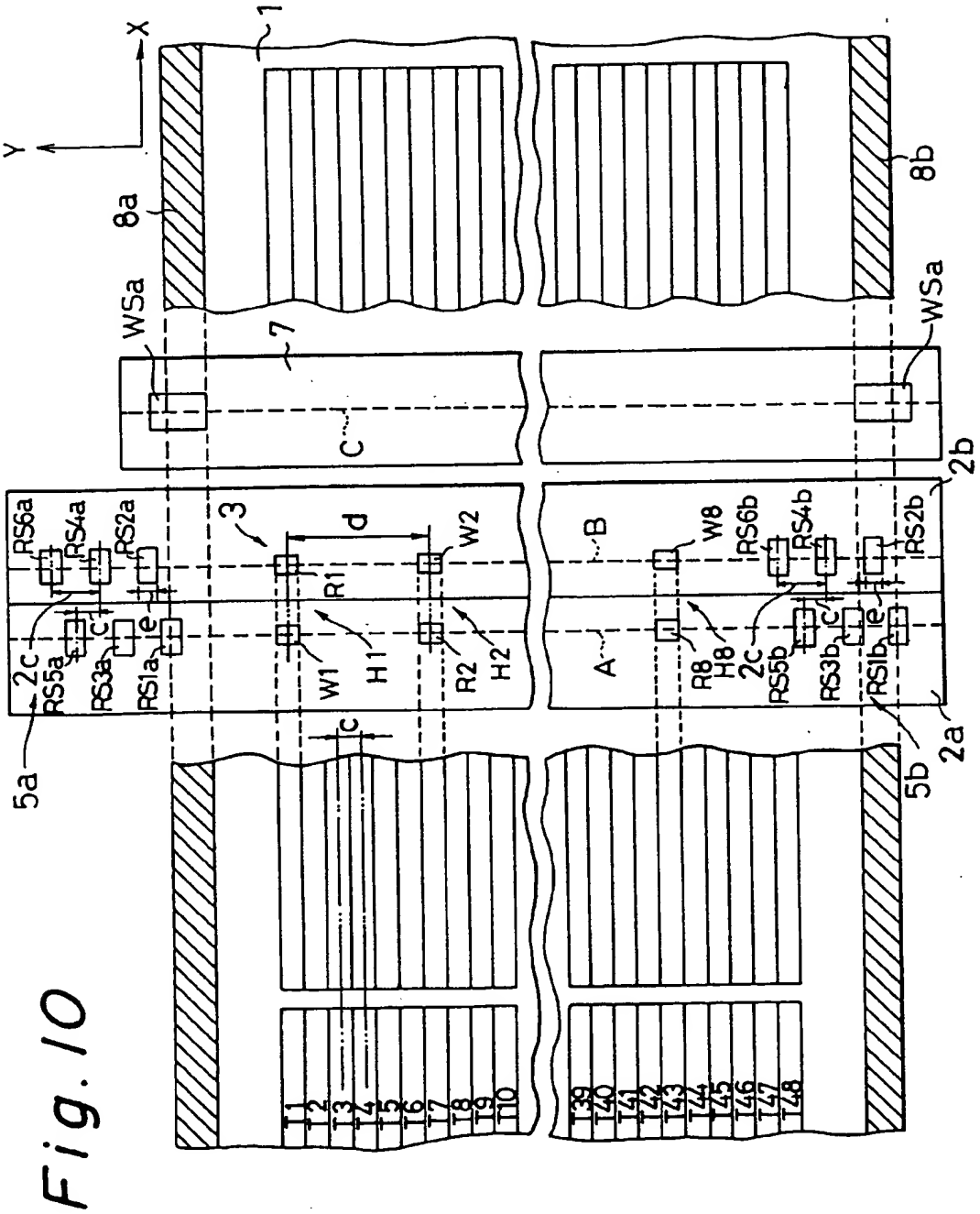

X
Y
1
8
7
WS
C
2b
3
RS6
RS4
RS2
d
W2
B
W8
R1
2c
RS5
RS3
RS1
W1
H1
R2
H2
A
R8
H8
5
2a
c
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 9


X
Y
1
8a
8b
WSa
WSa
7
C
2b
3
d
W2
R1
W1
H1
R2
H2
B
W8
R8
H8
A
RS6a
RS4a
RS2a
RS6b
RS4b
RS2b
2c
RS5a
RS3a
RS1a
RS5b
RS3b
RS1b
c
e
5a
5b
2a
T1
T2
T3
T4
T5
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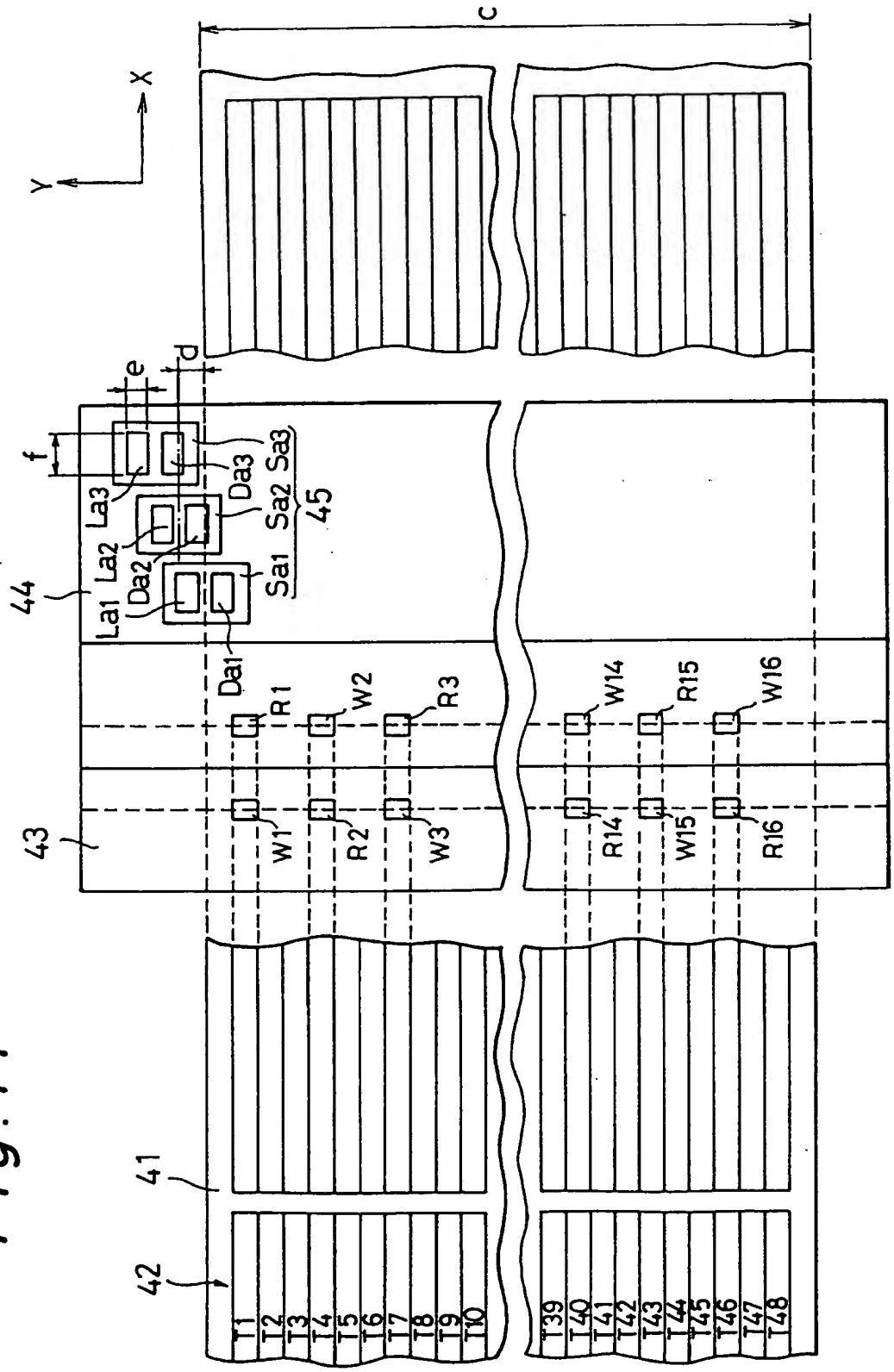
T48

Fig. 10

Fig. 11


c
X
Y
e
d
f
La3
Da3
Sa3
Sa2
45
La2
Da2
Sa1
44
La1
Da1
R1
W2
R3
W14
R15
W16
43
W1
R2
W3
R14
W15
R16
41
42
T1
T2
T3
T4
T5
T6
T7
T8
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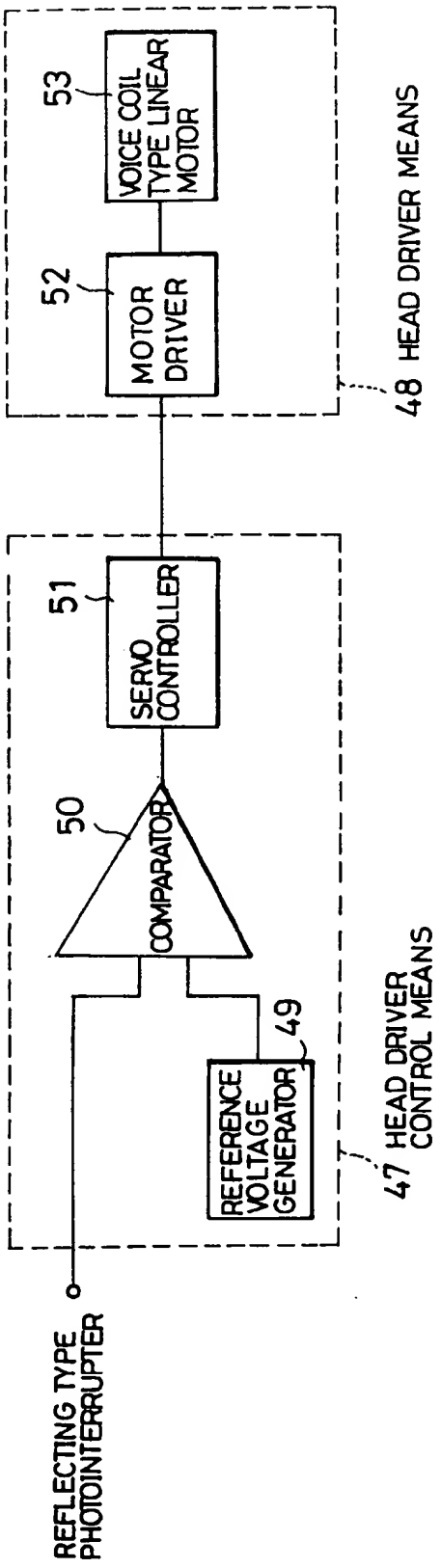
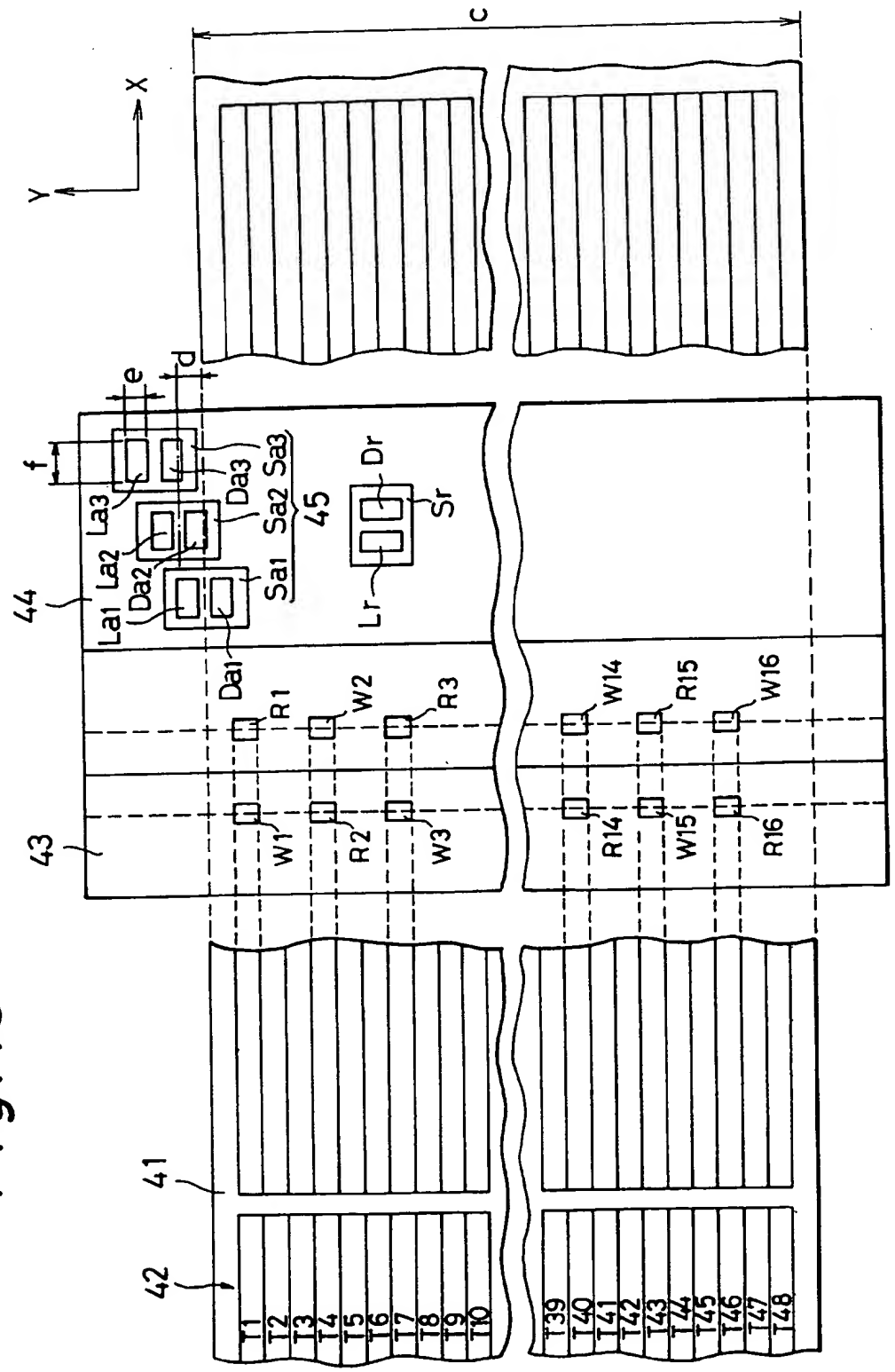
T39
T40
T41
T42
T43
T44
T45
T46
T47
T48

Fig. 12


53
VOICE COIL TYPE LINEAR MOTOR
52
MOTOR DRIVER
48 HEAD DRIVER MEANS
51
SERVO CONTROLLER
50
COMPARATOR
49
REFERENCE VOLTAGE GENERATOR
47 HEAD DRIVER CONTROL MEANS
REFLECTING TYPE PHOTOINTERRUPTER


C
X
Y
e
d
f
La3
La2
La1
Da3
Da2
Da1
Sa3
Sa2
Sa1
45
Dr
Sr
Lr
44
43
41
42
R1
W2
R3
W1
R2
W3
W14
R15
W16
R14
W15
R16
T1
T2
T3
T4
T5
T6
T7
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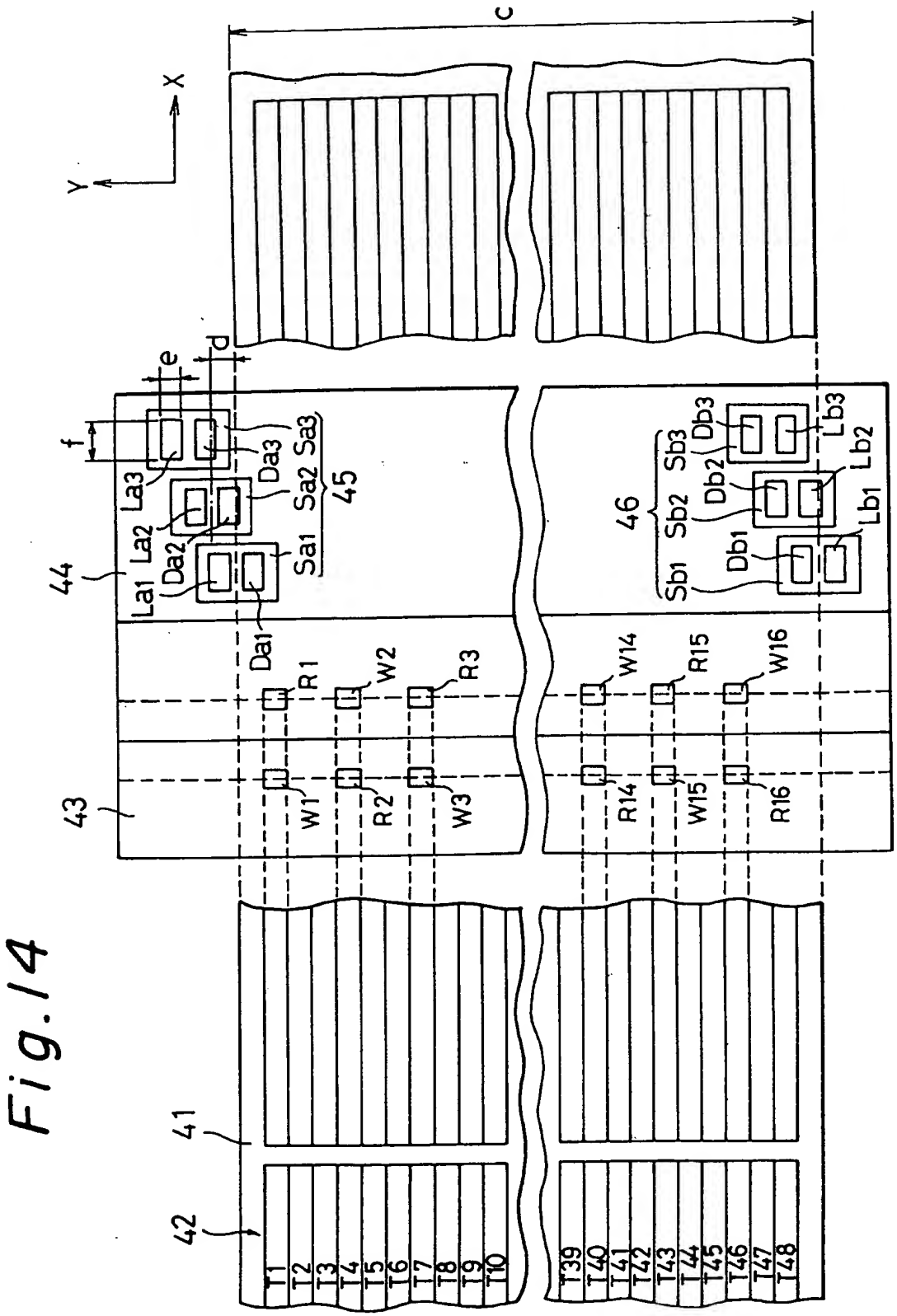
T44
T45
T46
T47
T48

Fig. 13

Fig.14


c
X
Y
d
e
f
La3
La2
La1
Da3
Da2
Da1
Sa3
Sa2
Sa1
45
44
43
R1
W1
W2
R2
R3
W3
46
Sb3
Sb2
Sb1
Db3
Db2
Db1
Lb3
Lb2
Lb1
W14
R14
R15
W15
W16
R16
41
42
T1
T2
T3
T4
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T43
T44
T45
T46
T47
T48